

The Journal of Laryngology and Otology

EDITED BY
WALTER HOWARTH

WITH THE ASSISTANCE OF
G. H. BATEMAN R. G. MACBETH V. E. NEGUS
R. SCOTT STEVENSON J. F. SIMPSON

Contents

BRONCHO-ESOPHAGOLOGY IN GREAT BRITAIN—THE DEFINITION OF A SCIENCE—A PLEA FOR BETTER CO-OPERATION AND TEACHING	G. EWART MARTIN
RADON THERAPY OF NASOPHARYNGEAL LYMPHOID HYPERPLASIA IN CHILDREN	E. G. COLLINS, I. S. THOMSON AND G. E. SWINDELL
MUCOCOLES	M. J. TAMARI AND JAMES J. O'NEIL
CLINICAL RECORDS— A CASE OF NASOPHARYNGEAL CHORDOMA A CASE OF NON-METALLIC FOREIGN BODY IN THE ETHMOIDAL SINUS	A. S. HANDOURA BEY H. C. P. GUNEWARDENE
CLINICAL NOTES— TREATMENT OF MAXILLARY SINUSITIS BY INSTILLATION OF PENICILLIN	ALFRED WALFORD
SOCIETIES' PROCEEDINGS— NORTH OF ENGLAND OTOLARYNGOLOGICAL SOCIETY	
REVIEWS	MADIGAN ARMY HOSPITAL
ABSTRACTS— THE EXP THE NOC	GENERAL LIBRARY PROPERTY OF U.S.A.'S ARMY

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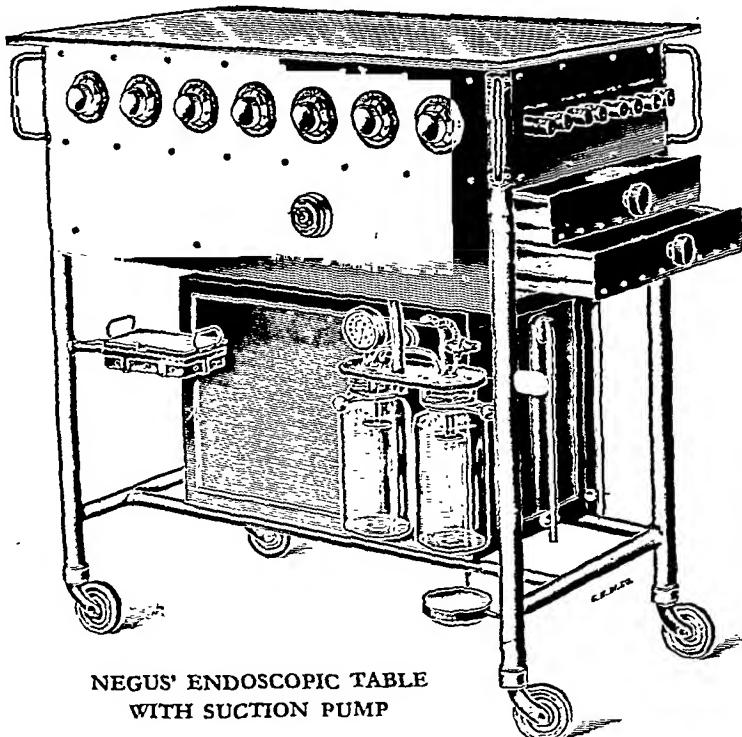
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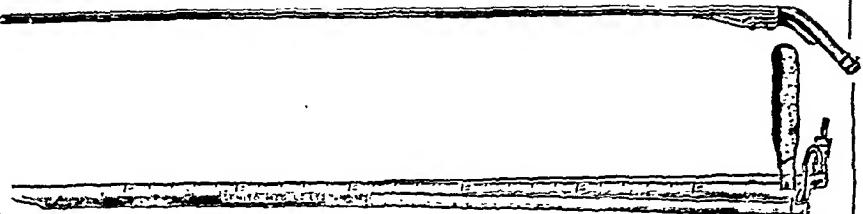
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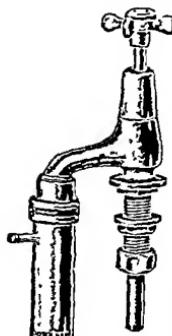
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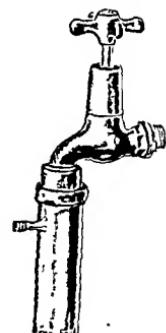
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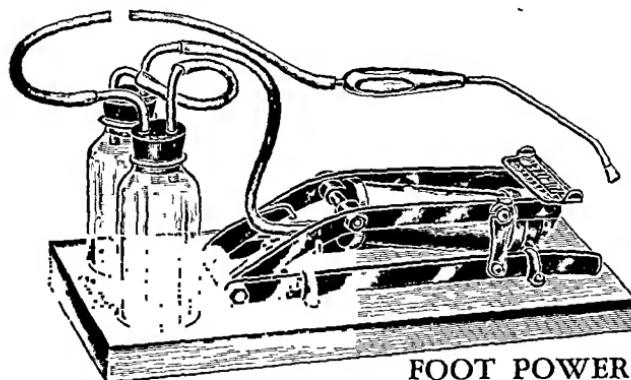


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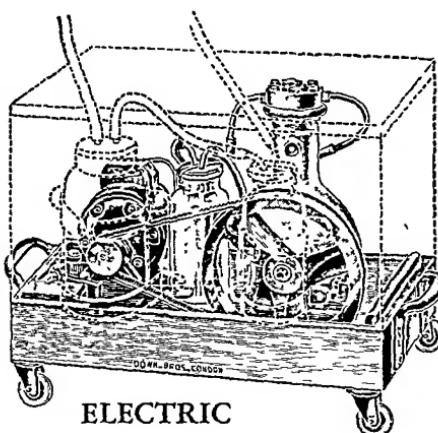
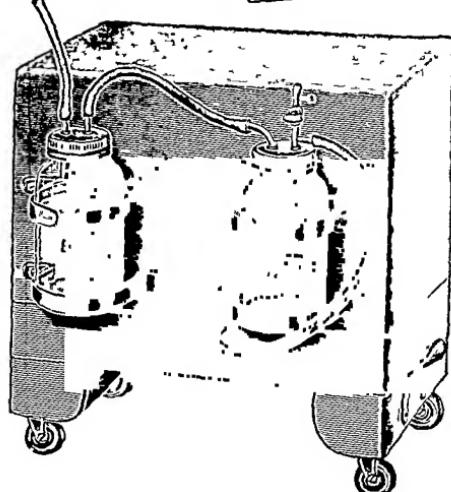


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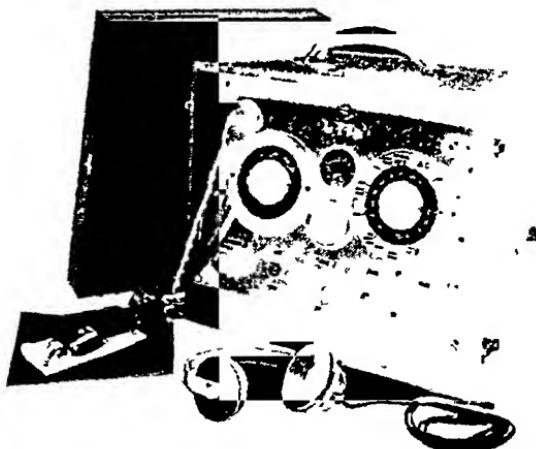
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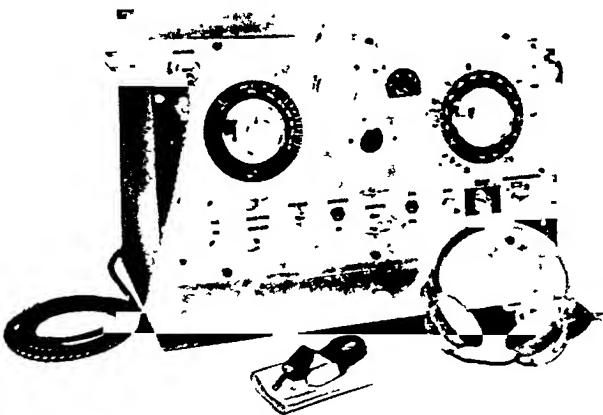
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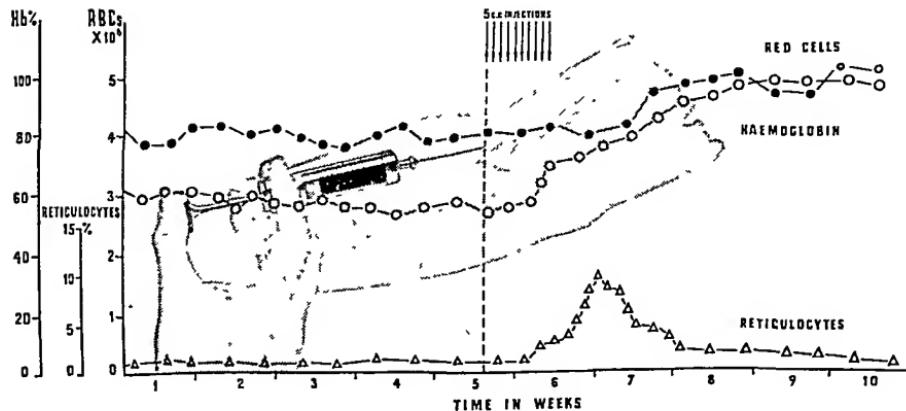
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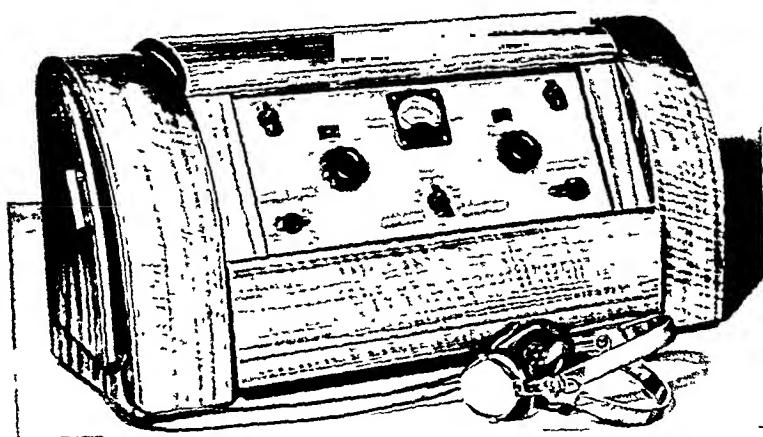
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CONTENTS

	PAGE	
BRONCHO-ŒSOPHAGOLOGY IN GREAT BRITAIN—THE DECLINE OF A SCIENCE—A PLEA FOR BETTER CO-OPERATION AND TEACHING G Ewart Martin (Edinburgh)	1	
RADON THERAPY OF NASOPHARYNGEAL LYMPHOID HYPERTROPHY IN CHILDREN. E G. Collins, I S. Thomson and G. E. Swindell (Aberdeen)	17	
MUCOCELES. M. J. Tamari and James J O'Neil (Chicago, Illinois)	24	
CLINICAL RECORDS—		
A Case of Nasopharyngeal Chordoma. A. S. Handousa Bey (Cairo, Egypt)	31	
A Case of Non-metallic Foreign Body in the Ethmoidal Sinus. H C P. Gunewardene (Ceylon)	34	
CLINICAL NOTE—		
Treatment of Maxillary Sinusitis by Instillation of Penicillin. Alfred Walford (Cambridge)	36	
SOCIETIES' PROCEEDINGS—		
North of England Otolaryngological Society	37	
REVIEWS		44
ABSTRACTS—		
Ear	52	
Some remarks on the Fenestration Operation and what leads to the results J Venker, Surgery of the Seventh Nerve Thomas D Tickle, M D , Chorda Tympani Nerve Graft Samuel Rosen, M D , Calcium and Phosphorus, and Phosphatase Activity in Otosclerosis Edmund Prince Fowler, M D		
Nose	54	
Tumours of the Nose and Sinuses LeRoy A Schall, M D , Disturbances of Olfaction resulting from Intranasal use of Tyrothricin Ernest M Seydel and William P McKnight, M D , Nonregeneration of the Mucous Membrane of the Frontal Sinus after its surgical removal (in the dog) George E Lieberman, M D and J W Babb, M D On the control of the Diphtheria Bacillus in the Chronically Diseased Nose W Messerklinger		
Miscellaneous	56	
Treatment of Migraine with Histamine Dorothy Macy, Jr, M D and Bayard T Horton, M D		

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January 1949

BRONCHO-ŒSOPHAGOLOGY IN GREAT BRITAIN—THE DECLINE OF A SCIENCE—A PLEA FOR BETTER CO-OPERATION AND TEACHING*

By G. EWART MARTIN (Edinburgh)

I SINCERELY appreciate the great honour which has been conferred on me by the Semon Lecture Board of the University of London in selecting me to give the lecture this year in memory of Sir Felix Semon.

To me it is a double or triple honour when I remember that my predecessor in charge of the Ear, Nose and Throat Department of the Edinburgh Royal Infirmary, Dr. Peter McBride, was selected to give the first lecture in appreciation of the life and work of his friend, Sir Felix Semon,¹ while my chief and teacher, Dr. Logan Turner, gave the lecture in 1923, the first after the 1914-18 war.

Title

The choice of a suitable title for this lecture has been a difficult one. The Semon Lecture Board gives the lecturer a wide latitude in the choice of subject as long as it comes within his specialty. I have chosen bronchoscopy—and I intend to discuss policy.

The Birth of Bronchoscopy

When the examination of the air and food passages below the larynx was made possible by the laryngologist, our specialty naturally extended its bounds to cover these new fields—a continuation downwards of the upper air passages. The examination of these air passages was termed bronchoscopy, that of the food passages œsophagoscopy; the whole being included in the term peroral endoscopy.

* The Semon Lecture, November, 1948

G. Ewart Martin

Broncho-œsophagology built on Laryngology

These examinations which took place through rigid, electrically lighted, tubes, opened up new vistas from which emerged the science of broncho-œsophagology, just as our knowledge of the larynx—laryngology—developed from Garcia's first glimpse into a laryngoscopic mirror, illuminated by the sun.

A science must have its masters and its teachers. Broncho-œsophagology was built up by our specialty, who were its initial teachers. But, since the mid-war years it has been slipping out of our hands, becoming no longer a specialty, but merely a very necessary examination. Consequently it is no longer being systematically taught.

Without experience who is there to teach it?

Logan Turner's Semon Lecture

Dr. Logan Turner's Semon Lecture with the title "The Advancement of Laryngology and Otology" was a plea for adequate training and close co-operative action between our specialty and the other branches of medicine, and also amongst ourselves. In this lecture I can only hope to reiterate his plea.²

His closing quoted sentence urged that we should co-ordinate our departments and place our specialty in a position at least as high as that then occupied by internal medicine and surgery. "Every step we take in the improvement of university education gives us a platform from which to start in order to make other and better arrangements."

A quarter of a century later I have to confess that many of the precepts of Dr. Logan Turner have not been entirely fulfilled. Our specialty, though possibly of greater power politically, has now a narrower scope than appeared possible after the first World War. The neuro-surgeon has extended his field down to the accessory sinuses and encroached on the petrous bone. The thoracic surgeon has commandeered the bronchus and the trachea and is furthering his way upwards to the larynx.

Semon's outlook on Laryngology

Semon envisaged his own specialty of laryngology as a unit in itself. He contended that for public purposes laryngology and otology should be considered separately, and he bitterly opposed the suggestion that the laryngologist should extend his operation area to the surrounding fields of the neck and face. In his autobiography he states that he had strictly limited his practice to his specialty and never favoured excessive use of surgery.³

In the advance of medical science, the laryngologist, had he kept to the narrow fields of Semon, would have had only a pin-hole view of that advance. Anyone who would hope to benefit humanity by supervising

Broncho-œsophagology in Great Britain

this area of our specialty must be a trained surgeon, physician and specialist in one.

The Fusion of Otology and Laryngology

Many of Semon's colleagues found the field of laryngology not sufficiently remunerative and became oto-laryngologists, combining what at that time tended to be two distinct specialties. Nowadays most of us are oto-laryngologists although some have a leaning towards the ear and others to the throat. Some may still combine laryngology with the science of the chest and become, not oto-laryngologists, but, laryngo-broncho-œsophagologists.

Semon on Bronchoscopy

Semon makes only a fleeting reference to bronchoscopy, certainly not deeming it a possible branch of laryngology, although he must have been cognisant of Killian's first removal of a foreign body from the bronchus in 1897 and also of his later lecture to the British Medical Association at Manchester in 1902.

During the years prior to Semon's retirement in 1909 bronchoscopy in this country was considered much more of an interesting sideline than an embryo science. On the Continent and in America it was advancing. I surmise that it was the recognition of this advance that led the Semon Lecture Board to invite Killian to give the second Semon Lecture.

The Early Days of Bronchoscopy

I must perforce refer to the early days of bronchoscopy, for without doubt it had a very slow beginning in this country. I can find no mention of it in the proceedings of the various Society Meetings interested in laryngology until the British Medical Association Meeting at Manchester in 1902 when Killian contributed his paper entitled "Direct examination of the lower air and food passages". In this paper he referred to some twenty bronoscopies performed by himself, Coolidge, Hajek, von Eicken and Neumeyer. There was no reference to any from Great Britain.

Killian's ideals of Bronchoscopy

In his concluding sentences Killian said: "I hope that my brief remarks will suffice to convince you of the high values of the direct methods of examination in the diagnosis and treatment of foreign bodies in the œsophagus and air passages. May you soon make yourselves adept in these methods and you will, I feel sure, do a great service to suffering humanity."

G. Ewart Martin

Early Endoscopists in this Country

This communication of Killian's seems to have made little impression on the physicians of the day. No reference was made to the paper apart from the reports of the sections of laryngology. However, it did inspire our specialty; communications appeared in medical literature by Waggett of London, Paterson of Cardiff, William Hill, E. D. D. Davis, and Irwin Moore of London, and Brown Kelly of Glasgow, to mention a few. Each laryngologist of that time tried his hand at passing a bronchoscope, hoping and praying for a foreign body to lodge itself in the bronchus! There was no question of putting bronchoscopy on a scientific basis—it became a branch of laryngology lower down the anatomical, or should I say, social scale.

Brünings' Text-Book

On the Continent, in Vienna, Budapest and Paris, clinics were in the process of establishment. Brünings—Killian's first assistant—developed the armamentarium of his chief and in 1910 published a text-book on the methods and technique of direct laryngoscopy and bronchoscopy. In 1912 this was translated by Howarth who had worked in Killian's clinic in 1908 and became the text-book of our early endoscopists.⁵

In spite of the interest shown and in spite of the recognition of the necessity of endoscopy, little progress was made in fostering its teaching in British hospitals.

In 1904, the doyen of American bronchoscopy, Jackson of Philadelphia (to whom in Semon's biography there is only a passing reference) developed the distal lighted oesophagoscope, and in 1907 (three years before Brünings) he published his first work entirely confined to the subject of tracheo-bronchoscopy and oesophagoscopy—a book enlarged in 1914 and called *Peroral Endoscopy*. Medical text-books published during this period make no mention of the necessity of obtaining an inside view of the bronchus.⁶

In Edinburgh the possibility of examining the bronchi and oesophagus was first ventilated in a paper read to the Medico-Chirurgical Society in 1913 by Dr. Logan Turner and Dr. J. S. Fraser. I had been privileged to assist Dr. Logan Turner in two of these early bronchoscopies. The cords were exposed by a Linah type of suspension apparatus and the bronchoscope passed between the cords. In the paper under review the pathology of the oesophagus was mentioned, but there was no thought of bronchoscopy except as a means of removing a foreign body from the bronchus.⁷

Jackson's Bronchoscopic Clinics

There is no doubt but that the first World War interfered with the progress of bronchoscopy in this country. There was very little opportunity in Europe for work of this nature. Fortunately in America

Broncho-œsophagology in Great Britain

under the guidance and influence of Chevalier Jackson endoscopy made rapid strides. Already after the war a bronchoscopic clinic had been established in Jefferson Hospital and an Endoscopy course had been organized by the Post-graduate School of Medicine of the University of Pennsylvania. There the post-graduate clinic had its own lecture rooms, examination rooms, laboratory and special rooms for experimental work on dogs. Beds were reserved in the Jefferson Hospital for bronchoscopic cases. Chevalier Jackson and Gabriel Tucker, and later Louis Clerf, devoted most of their time to endoscopic work. It was all very impressive, especially to one who had only seen or helped with an odd bronchoscopy—here was a new specialty—an advancement in laryngology, taught by laryngologists, who, in their teaching, were very definite that no one should pass a bronchoscope or œsophagoscope without a thorough knowledge of the anatomy, physiology and pathology of the larynx and upper air passages.

Practice in this Country

At home there was no possibility of practice save on the cadaver, the mannikin or the living subject under an anæsthetic. The use of dogs as patients was not allowed—anti-vivisection regulations practically prohibited demonstrations on living animals. For experimental work we could obtain a licence to carry out examinations under an anæsthetic, but a licence was not necessary for bronchoscopy in dogs under an opiate, though, if we did so, we laid ourselves open to persecution and possibly prosecution by an anti-vivisectionist.

After the influenzal epidemic of 1918 there were a great many cases of bronchiectasis mainly secondary to an unresolved pneumonia. I had the opportunity of seeing some of these cases. Many of them responded effectively to bronchoscopic suction and lavage. The cases were referred from all the Medical Wards for examination, the physicians being only too willing to have something done for the chronic cases which were occupying badly wanted beds. These cases gave an opportunity for practice on the living subject. This bronchoscopic treatment of infections of the chest had not been envisaged by Killian when he removed the first foreign body from the bronchus. It was an advance in bronchoscopy.⁸

Those of our specialty who visited Jackson came home with a vivid picture of what had really become a specialty within the precepts of the specialty of laryngology. Negus with his inventive genius and his appreciation of the physiology and anatomy of the larynx made his clinic in King's College Hospital, London, world famous. He was not satisfied with the illumination supplied by the Jackson instruments, but improved upon these; and the Negus tube is now the instrument of choice of many endoscopists.

The examination of the bronchus became a common proceeding in an

G. Ewart Martin

oto-laryngological department, but there was an absence of co-operation between the physician and the specialist. This was so much the case that in a text-book on Cancer of the Lung, published as late as 1930, there is this statement : "The use of the bronchoscope as an aid to the diagnosis of various intrathoracic diseases, though it has been employed with regularity and considerable success in most of the best known American clinics, has, unfortunately, been a good deal neglected in this country." But the facts are that the Sections of Laryngology had many communications made to them on the use of the bronchoscope in diseases of the lung.

In 1925 Dr. Chevalier Jackson read a paper to the British Medical Association, Section of Oto-laryngology, on overlooked foreign bodies in the bronchi. It was a striking tribute to him, with a little reflected glory on the oto-laryngologists, that the Section of Medicine postponed its ordinary meeting in order to allow the members to attend this address.

In commenting on this meeting, the editor of the *British Medical Journal* said, "Each and every laryngologist will become his own endoscopist. Every young laryngologist should consider the subject a part of his specialty and train himself to be capable of dealing with any case of foreign body which may come under his care."

The public press became interested in this meeting and glowing accounts of the new methods appeared in the daily papers.

From now on, the trainee laryngologist was expected to have some knowledge of endoscopy. He was expected to be able to remove any foreign body from the bronchus or the oesophagus which was referred to his Department. In certain E.N.T. clinics, such as in King's College Hospital, London, Brown Kelly's Department in Glasgow, and my own Department in the Edinburgh Royal Infirmary, sessions were given over to bronchoscopy and oesophagoscopy. There endoscopy could be demonstrated to the trainee, but the practice necessary to the post-graduate could not be provided. He could see the various methods of examination, but his only hope of practice was on the living subject under an anaesthetic. There was no clinic devoted to bronchoscopy ; no beds were set aside for endoscopic cases—bronchoscopy was just a part of laryngology. In other words the laryngologist, with little or no training and less practice ; with quite often a poor armamentarium, was expected to remove any foreign body from the bronchus or oesophagus. As a natural sequence there were many failures.

In Paris, with the co-operation of Professor Soulard, clinics were started by Chevalier and C. L. Jackson. These clinics gave the opportunity to the younger laryngologists for practice in bronchoscopy.

In America bronchoscopic clinics were attached to many of the larger hospitals, staffed by laryngologists who had decided to devote their whole time to endoscopy.

Broncho-œsophagology in Great Britain

In Britain where hospitals, especially those attached to teaching centres, were on a voluntary basis, the expense of new clinics could not be faced. In his own department the laryngologist developed endoscopy as time and place allowed, treating it as a routine examination. It is regretful to suggest that a mercenary viewpoint had a bearing on the evolution of a science, but there is no doubt that endoscopy was not remunerative. The armamentarium was necessarily large and difficult to transport from hospital to Nursing Home. Where difficulties were anticipated, private cases were perforce admitted to general wards. For this reason many laryngologists found little attraction in endoscopy—this seemed perfectly logical in the days when a man's hospital appointment was simply an advertisement of his private practice, not his means of livelihood.

As the special departments for oto-laryngology became overcrowded endoscopy had often to be shelved. Where, however, it was being done systematically there appeared possibilities in the treatment of diseases of the lower air and food passages.

Unwittingly the laryngologist was laying the foundations for the tremendous advance in thoracic surgery. As Jackson mentions "Look and see" became the order of the day.

The Thoracic Surgeon and Bronchoscopy

The thoracic surgeon had to obtain an inside view of his operative field, so the bronchoscope became to him what the cystoscope was to the urologist. Its original use for the removal of foreign bodies was almost forgotten in its new role of diagnosing pulmonary lesions. The thoracic surgeon had to train himself to pass a bronchoscope through the larynx in order to see the lumen of the trachea and bronchus, to see the limitations of the growth he hoped to remove surgically, but, his only practice was on the cadaver or the pathological living subject referred for operation. Once again the bronchoscope was being used without previous opportunity of practice. Thus, after the second World War the thoracic surgeon was on the same footing and faced with the same problems as the young laryngologist of previous years, but with one specific difference, the laryngologist knew and respected the upper air passages while in many cases the thoracic surgeon, unfortunately, set himself to deal with a chest condition that had its source of infection in the nose or sinuses.

During the last war many laryngologists were attached for service with the Navy, Army and Air Force abroad. Their own hospitals at home were thus so under-staffed that there was no time for bronchoscopy, and no one to carry it out. During these same years tremendous strides in thoracic surgery were manifest, and in many centres the thoracic surgeon, whose work was mainly at home, became the sole endoscopist for the area.

When the laryngologist returned to his own Department, he found he was expected to carry out endoscopic emergencies; cases were also

G. Ewart Martin

referred to him for report on the oesophagus. This in itself is a curious anomaly ; the thoracic surgeon with a student's knowledge of the upper air passages was superintending the examination of the lower airways, while the laryngologist, without any opportunity of practice, was expected to tackle the mechanical and anatomical problems of the removal of the foreign body from the bronchus and oesophagus. The change over becomes still more curious when we remember that the first oesophagoscopy was carried out by a surgeon on a sword swallower who, it is said, passed the instrument himself. That was Kussmaul in 1868 using an instrument suggested by Bozzini and perfected by Desaumeral, for the examination of the bladder ; while the first operation on the bronchus was by a laryngologist—Killian just over fifty years ago.

To enable me to ascertain the position of bronchoscopy in this country I enlisted the help of my friends and colleagues in various centres. Their replies were reported fully in my communication to the American Medical Association, last year.

However, it might be informative to give the position of endoscopy as I see it from these sources, mentioning briefly a few centres.

Position in this Country

In Newcastle the thoracic unit carries out all its own endoscopies. The E.N.T. Department has its own bronchoscopic unit. Unfortunately there is no co-operation between the two Departments.

In Leeds all endoscopic examinations are in the hands of the thoracic surgeon. Cases are referred to the laryngologist for report on the larynx and the upper airway.

In Sheffield and Bradford all cases are referred to the E.N.T. units.

Very little endoscopic work is now referred to the Nose and Throat Departments in Derby where before the war there was a large, well known, bronchoscopic department.

The large thoracic units in Manchester and Birmingham are under the care of surgeons who have been trained in endoscopy in the Jackson clinic in Paris or in the States. A certain number of cases are still being referred to the E.N.T. units.

In Nottingham there is a large, well-equipped, bronchoscopic clinic attached to the E.N.T. Department. Before the war the work was done there for the thoracic surgeon with complete co-operation between the E.N.T. and the thoracic units, but during the war they unfortunately drifted apart.

In Oxford there is closer co-operation between the thoracic units and the E.N.T. unit.

In Cardiff the position is solved by the fact that the cases are all admitted through the main out-patient departments, thereby preventing the thoracic units becoming a "closed shop".

Broncho-oesophagology in Great Britain

In Scotland most centres have bronchoscopic clinics attached to the E.N.T. Departments with co-operation with the thoracic surgeons, although there are separate thoracic units which carry out their own endoscopic work.

London epitomizes the work of the rest of the country. In the early days the largest bronchoscopic clinic was sponsored by two physicians, Pinchin and Morlock, but one cannot think of the Brompton Hospital without mentioning the work of Ormerod, especially on cancer of the lung.

Tudor Edwards believed that all bronchoscopy should be done by the thoracic surgeon, consequently his influence was responsible for the establishment of thoracic units without the co-operation of the laryngologist.

A foreign body clinic was established by the London County Council which was unfortunately interrupted by the war.

I should like to incorporate an excerpt from a letter from Mr. Negus which emphasizes my own view on our specialty.

"In London the thoracic surgeons are doing large numbers of bronchoscopic examinations, and are removing foreign bodies. They also carry out oesophagoscopies and this practice is increasing. Sometimes they ask me for help with an oesophagoscopy but never with a bronchoscopy. There are two physicians at the Chest Hospital who do bronchoscopic work. I think it is unfortunate that endoscopy is being monopolized in this way. Although I feel that the thoracic surgeon should examine the bronchi and the oesophagus of a patient on whom he may operate I think that in cases which are unlikely to require external operation endoscopy should remain in the hands of the laryngologist. There are laryngologists in all the large towns, but not thoracic surgeons, and therefore it is highly important that they should be properly trained, particularly in the removal of foreign bodies. This can only be obtained by constant practice in cases where there is no foreign body, such as bronchial and lung abscesses, bronchiectasis, and the various oesophageal diseases. Our relations with the thoracic surgeons have been perfectly cordial but, nevertheless, I feel that there should be a determined effort to prevent endoscopic work drifting too much into their hands."

In America, from the days when broncho-oesophagology was recognized as a science, it grew apart from laryngology. Many of the bronchoscopic clinics already mentioned have merged into the thoracic units. It is recognized, however, that endoscopy is not an examination which can be performed without practice, and the mere passing of a tube is not all that is necessary. In his early precepts Chevalier Jackson stated that more deaths were caused by the attempted removal of a foreign body from the bronchus than by its presence in the bronchus. That still holds to-day.

G. Ewart Martin

In Philadelphia there are three large bronchoscopic units where thoracic surgeons from all the Americas may receive their training along with the laryngologists from the smaller towns who are still carrying on bronchoscopy.

Lyman G. Richards' views

In an informative communication from the Department of Bronchoscopy of the Massachusetts Eye and Ear Infirmary, Lyman G. Richards discusses the position of bronchoscopy as he finds it in the U.S.A. He deplores that the traditional bronchoscopist is denied practice. He is supposed to deal with foreign bodies, yet, he cannot give an opinion on the bronchus in disease.¹⁰

In a questionnaire Dr. Richards sent to members of the American Association of Thoracic Surgeons it was disclosed that 33 per cent. did their own bronchoscopies and 53 per cent. had them done by the trained laryngologist. To a similar questionnaire sent to the Chest Physicians the reply came, 11 per cent. did their own bronchoscopies and 65 per cent. had them done by the trained laryngologist. 67 per cent. of the chest physicians expressed the belief of the continued divorce of bronchoscopy from the field of oto-laryngology. A considerable number of specialists in this group were engaged principally in the treatment of pulmonary tuberculosis. Although they recognized that the opinion of the laryngologist was necessary in conditions involving the larynx they doubted if he had sufficient knowledge of pulmonary pathology to extend his field below the larynx.

Dr. Richards refers to yet another group—the American Gastro-enterological Association. 80 per cent. of the members of this Association relied on the trained laryngologist for a report on the oesophagus.

Finally, information was sought from the members of the American Broncho-oesophagological Association. The members of this Association, with a few exceptions, may be termed the traditional bronchoscopist, i.e. one who has approached bronchoscopy through the knowledge of rhino-laryngology stimulated by the teaching of Killian, Jackson and Mosher. Naturally this group was more interested in the possibility of practice in bronchoscopy. 60 per cent. replied that there was an increased tendency for the chest surgeon to do his own bronchoscopies and oesophagoscopies. 84 per cent. of these traditional bronchoscopists still did all endoscopic examinations for the chest surgeons in their area. The answers varied with the locality in which the bronchoscopist carried out his work and with the size of the area covered. In the smaller towns 98 per cent. of the bronchoscopies were for foreign bodies only. In these smaller towns the bronchoscopist was not capable of giving definite data as regards lung pathology. This last comment raises again the vital point in the whole controversy—the few foreign body cases which

Broncho-œsophagology in Great Britain

come his way will not train the bronchoscopist in the varied diagnostic and therapeutic procedures which are more essential for him to master if he is to fulfil the qualifications required by the present-day thoracic surgeon.

These were Lyman G. Richards' views expressed in 1942. Since then the membership of the American Broncho-œsophagological Association has increased, including thoracic surgeons. I have the honour to be a corresponding member of this Association the objects of which are to promote the knowledge of diseases and injuries of the respiratory and upper digestive tracts, and of borderline conditions; their diagnosis and treatment by means of direct or indirect inspection; co-operative effort with the allied specialties; the fostering of friendly assembly and of scientific stimulations among members of the Association; the advancement of the art of Broncho-œsophagology. Why have we no similar Association?

I have described as briefly as possible the rise of bronchoscopy under the ægis of the laryngologist. I have tried to show the present position of bronchoscopy in the hands of a few laryngologists.

Our specialty has never become stereotyped (thanks to those brilliant teachers of ours, who seemed to revel in disagreement).

Some of us practice bronchoscopy as part of our own specialty; others, through apathy or through the exigencies of the daily round pay no heed to the necessity of obtaining practice in endoscopy.

Principles of Bronchoscopic Practice

If we are to continue these principles we must remember that like art, medicine is an exacting science. We cannot hope to give a considered report on a pathological condition when we scarcely know the normal. We cannot pick out the foreign body whose mechanics we have not studied.

Often it would seem that Killian's original removal of a foreign body from the bronchus through a bronchoscope labelled it as an instrument for that purpose only.

The thoracic surgeon has upheld this country's prestige in experimental medicine and surgery. The work of Tudor Edwards is world known. Brock of Guy's Hospital and Brompton Hospital has given us a greater anatomical knowledge of the bronchi and lungs.

The necessity for Bronchoscopy

What then is the necessity for bronchoscopy?

Bronchoscopy is the preliminary to any operation on the bronchus by the thoracic surgeon.

Bronchoscopy is an essential to the physician, for, in many cases,

G. Ewart Martin

an examination of the chest cannot be concluded without a bronchoscopic report.

The radiologist cannot give a definite opinion on an obscure shadow in an X-ray, but must appeal to the endoscopist for help.

May I be allowed to illustrate this from personal experience.

Since the end of hostilities in 1945 to the present date, among many other cases, 283 cases have been referred to me from the physicians or from the radiologists for a further bronchoscopic report. One hundred and four of these cases proved to be cancer of the bronchus, confirmed by biopsy or cell suction. The larger proportion of these were too advanced to allow of operative interference. My own unit is one of three in the south-eastern area of Scotland. The figures of the other units are not so high, but the combined figure of cancer of the bronchus during these years is appalling. So far there is no hope of cure unless the diagnosis is early enough to allow of surgical removal of a lobe or a lung.

In an effort to promote early diagnosis special attention has been paid in my Department to symptomatology. Previously medical textbooks suggested that cough and haemoptysis were the early symptoms of cancer of the lung. Of the cases under review 25 per cent. only had haemoptysis, 33 per cent. complained of pain, and 90 per cent. complained of cough. 8 per cent. were discovered on mass radiography, evidently symptom free. All the cases complained of curious breathlessness accompanied by unexplained tiredness. To give a shadow on an X-ray film there must be moderately extensive underlying lung disease. Diagnosis should be possible before the lung fields appear blurred on an X-ray film. If the physician is in doubt about any chest lesion he should refer the case to the bronchoscopist for report.

Physicians doing their own Bronchoscopies

Realizing this, some physicians have elected to do their own bronchoscopies. For this there must be a theatre available which is not usually possible in most general hospitals.

Cancer of the lung has given rise to a problem which the bronchoscopist alone can solve.

But there are many other problems which are too numerous to mention.

There is the problem of the foreign body in the bronchus. This is not merely a mechanical problem, the removal of a foreign body without injury to the surrounding structures, but it implies the diagnosis of the unsuspected foreign body. This can only be obtained with complete co-operation between the radiologist and the bronchoscopist. More foreign bodies in the bronchus are reported in American literature than in our own. Personally I think the reason for this is that here many foreign bodies in the lung remain unsuspected. During the last two years

Broncho-œsophagology in Great Britain

I have seen four cases which were referred to me by physicians because of a slight shadow in the lung field as query tumours (one case had haemoptysis). All these cases proved to be foreign bodies. One of them a false tooth which showed no characteristic shadow ; one a small plastic mould ; the third a mass of vegetable material and the fourth a keratin coated pill. After the removal of the latter the patient remembered that four days before an attack of so-called pneumonia, one of three pills which he was taking for constipation had gone down the wrong way.

The laryngologist in the past has undertaken the examination of the bronchus for foreign bodies. Seeing the normal in all these cases has helped the recognition of the abnormal and experience has been gained by the examination of many cases of lung disease—cases which are now being referred to the thoracic unit.

There are two other problems to which I would like to refer in passing. One is post-operative collapse of the lung ; the result of a plug of mucous blocking the bronchus. This accident (if it can be so called) is fortunately recognized by the anæsthetist who can apply suction to the bronchi. In fact it has been suggested that the bronchoscope should be part of the ever-growing armamentarium of the anæsthetist. If this plug of mucous is unsuspected by the anæsthetist it will give rise to general lung symptoms which can be relieved only by early bronchoscopic examination and suction.

The other problem is the lung abscess which may be a sequela of the previous problem. If undiscovered and untreated there will be permanent damage which in its turn can be relieved only by lobectomy or pneumonectomy.

Like bronchoscopy, œsophagoscopy has its problems. œsophagoscopy is a more difficult examination. The mucous membrane of the œsophagus is more readily torn and though chemio-therapy has, to a certain extent, lessened the possibility of a mediastinitis following on a tear of the œsophagus the danger is still present. Cancer of the œsophagus is possibly not so common as cancer of the bronchus. In the past three years among 405 œsophagoscopies, 78 were proved to be cancer, by biopsy. It is interesting to note how many cases that are sent for report as possible strictures of the œsophagus are in reality congenital shortening—some with peptic ulceration.

What of the future of bronchoscopy ?

Each to his own ability, the laryngologist has carried out endoscopic examinations. He has gained his experience from the number of cases referred to him by the physicians. There has been no centralization of these cases so as to allow of more experience and more experimental research.

The oto-laryngologist, whose out-patient department is increasing beyond all bounds, cannot be expected to overtake all endoscopic work which should be presented by the physician. It is doubtful whether

G. Ewart Martin

the thoracic surgeon could undertake it. He has forsaken general surgery : he has set himself to obtain a knowledge of pulmonary pathology : he has made himself familiar with disease of the chest from the medicinal standpoint : and it is only right he should see the inside of the lung before opening the thorax. He has to spend long hours operating, and cannot possibly oversee all the preliminary inspection.

The physician requires a bronchoscopic report to complete his diagnosis ; it might be a terrifying experience to the patient with an in-born fear of the knife to be transferred to a surgical department for this report. Without doubt there is a definite need for an endoscopic department and for co-operation between the physician, the bronchoscopist and the thoracic surgeon, just as in the past it was found necessary to establish urological departments in certain centres where the physician, surgeon and urologist worked together. There is this co-operation in certain centres, but the links are light and casual and therefore easily broken.

In America it is recognized that the laryngologist can no longer expect to be his own bronchoscopist. In the first place he has little time to gain experience, and little time for practice : and it does require practice even to remove a foreign body.

Those of us who have spent some years on endoscopy know that it is very much easier to pass a bronchoscope than an oesophagoscope. It is very much easier to examine the inside of the lung than to be sure of the "nooks and crannies" of the oesophagus and the upper part of the stomach.

The early advances of thoracic surgery were more manifest in work on the heart and lungs than on the oesophagus, apart from the spectacular work of Gray Turner and Tudor Edwards. As a consequence in some centres where bronchoscopic cases were referred to the thoracic surgeon, oesophageal cases continued to be sent to the E.N.T. Departments. Bronchoscopy was being divorced from oesophagoscopy. The picture of the chest was being blurred.

What of the teaching of bronchoscopy and who is to teach it ?

When Peter McBride gave his first Semen Lecture he sketched our specialty as it was in Semen's early days, showing that laryngology, then a comparatively young off-shoot of its parent stem, medicine, was regarded by the physicians of the day with suspicion and indifference. When Logan Turner gave his lecture, the General Medical Council had just decided that laryngology should be a compulsory subject in the medical curriculum. Its teaching varied in the different medical centres, from odd lectures and clinical demonstrations to the final year student, to a complete three months' course.

The student, during his period of training in diseases of the Ear, Nose and Throat, was given an inkling into bronchoscopy, sufficient to stimulate him to further enquiry after graduation.

Broncho-œsophagology in Great Britain

Now, during these present years, the student is being deprived of this slight knowledge and interest in endoscopy. There is less opportunity for teaching it in the E.N.T. Departments, and no time to teach it in the thoracic unit. He is falling between two departments, one teaching him the physiology as well as the pathology of the upper airways, but with little mention of their continuation to the chest, and the other simply dealing with diseases of the chest which have been referred to the department by the physicians for operative interference.

Those of us who have been connected with our specialty for a considerable number of years have our minds constantly turned towards the teaching of the younger laryngologist and of stimulating the post-graduate student in medicine and in surgery towards an interest in our specialty. If the endoscopic cases are not referred to our departments we cannot give the post-graduate any training in his examination of the lower air and food passages.

The problem of teaching the post-graduate student is a grave one. Like the undergraduate he also may fall between two departments.

During this year we are in the midst of a change-over to a new health service—a service for which, unfortunately, the profession as a whole was not ready. The regionalization of hospitals was an absolute necessity, but the regional schemes were not sufficiently organized before Nationalization took place. It may right itself in time and this regionalization may allow the specialty of broncho-œsophagology to free itself of the stigma of being merely an examination, and become, like its parent laryngology, a science. Those of us who have thought on wider lines than the narrow pin-hole view of Semon, realize that there must be a change.

Endoscopy cannot be handed over entirely to the thoracic surgeon unless he adds a knowledge of rhino-laryngology to his already crowded training. It must be evident that the larynx is not a barrier between two air fields, it is a swing gate—albeit, it sometimes creaks—through which there is a free air interchange. Any subversive influence on the upper airway must necessarily have an effect on its lower half.

Then also bronchoscopy and œsophagoscopy cannot be divorced.

The laryngologist cannot hope to gain experience in œsophagoscopy and bronchoscopy with the occasional removal of a foreign body, and be expected to teach endoscopy. Even an efficient armamentarium does not make him an endoscopist—he must have practice.

It seems unpolitic to divide the human airway between two specialties. Surely, under the new health scheme, this co-operation between the laryngologist and the thoracic surgeon should not be difficult of attainment. Clinics given over to endoscopy could be established in co-operation with the thoracic unit and the E.N.T. unit—possibly one endoscopic unit in the central hospital in each region, staffed from the various

G. Ewart Martin

sectors of the region, with beds set aside for endoscopic cases, though some cases might quite easily be examined as out-patients so as to obviate any delay—time being the principal factor. There, the trained laryngologist with his knowledge of the upper air passages may have to devote his whole time to gaining further knowledge of the lower air and food passages, specializing in endoscopy and working in close unison with the thoracic surgeon.

With his intimate knowledge of the upper air passages, if only he is given the opportunity of practice, he may be able to further his knowledge of the trachea, bronchi and the oesophagus, and thus revive in Britain the science of broncho-oesophagology. With a perfect inside knowledge of the chest the abnormal should be capable of early detection thus making possible an attack on lung pathology which has been impossible in the past.

Practice alone maketh perfect.

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RADON THERAPY OF NASOPHARYNGEAL LYMPHOID HYPERSTROPHY IN CHILDREN

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Introduction

THE work of Crowe and others in treating lymphoid hypertrophies of the nasopharynx in children by means of radium or radon has received wide recognition in America. A similar technique was also suggested by Fowler¹ for aerotitis among U.S.A.A.F. personnel, and reports from other U.S. Army specialists were published in the *Annals of Otology* (December 1945). Few reports of radon treatment to the nasopharynx have appeared in Great Britain. In a brief discussion at the Royal Society of Medicine a number of British rhinologists considered that such treatment might cause atrophic nasopharyngitis or result in stenosis of the Eustachian tubes owing to scar tissue formation.

The present article is a preliminary report on 41 children who have been treated at the Royal Hospital for Sick Children, Aberdeen, by radon applications to lymphoid hypertrophies in the nasopharynx. We have found that this form of treatment benefits two types of disease. The first is the child with catarrhal deafness, often accompanied by a loss of upper tones, and the second is the child suffering from chronic rhinitis, often associated with mucosal hypertrophy of the maxillary sinuses. The tonsils and adenoids have already been removed in the majority of these cases.

In this article we shall emphasize especially the results of treatment by radon therapy in the child with chronic rhinitis. Some cases of catarrhal deafness have also been included, but it is only during the last few weeks that it has been possible to check any improvement in the hearing of these children with an audiometer. Although symptomatic improvement in hearing did result, the omission of audiometric charts detracts to some extent from the value of the results.

The Causes of Persistent Catarrhal Rhinitis in Children and the Rationale of Treatment

All rhinologists are familiar with the persistent catarrhal rhinitis which occurs as the result of infected tonsils and adenoids, infected maxillary sinuses or allergic rhinitis. When all these diseases have been excluded there still exists a considerable number of cases where the only clinical findings are a rather granular pharynx and nasopharynx, often accompanied by some mucosal thickening of the maxillary sinuses on X-ray.

The aetiology of this mucosal thickening remains in doubt. Crooks² states that in 500 children under twelve who attended at Great Ormond Street Hospital in one year with opacity of one or both antra on X-ray, no less than 230 were clear on first antral lavage. A very similar proportion has been observed among the children attending our Out-Patient Department.

It has been suggested that the mucosal thickening results from a vasomotor disturbance, a virus infection or from avitaminosis, but there is little clinical evidence to support these suggestions.

We examined 13 of these patients more fully by the bacteriological examination of antral aspirations of saline obtained by means of a long sterile needle introduced through the antral cannula. We also made smears of the nasal secretions to determine if any eosinophilia was present. The results are recorded in Table I and shed no fresh light on the aetiology.

TABLE I

Mucosal Hypertrophy	Antral Lavage	Organisms on Culture	Sterile Culture	Eosinophilia
8	12 clear 1-½ c.c. of sterile fluid.	3-scanty St. Albus.	10	2 (2 or 3 cells).

We hesitate to add to the number of unsupported theories. Nevertheless we feel that the radiological improvement in our small series has been sufficiently marked to suggest that the mucosal thickening of the maxillary sinuses is a secondary reaction to infected lymphoid remnants in the nasopharynx, which are harbouring pathogenic organisms and are also interfering with proper nasal ventilation.

It is a fact that in a number of cases the mucosal hypertrophy disappears spontaneously as the child gets older, but in the interval the mother complains that the child has a constant cold. The disappearance of the mucosal hypertrophy in a number of children towards the age of puberty is quite possibly associated with the atrophy of adenoid vegetation and if so would support our theory.

Fisher³ has stated that after the removal of tonsils and adenoids, 75. per cent. of the patients show a compensatory hypertrophy of the lateral pharyngeal band, of the minute follicles studding the naso and oropharyngeal wall, and of the adenoid remnants round the Eustachian tubes. These latter are, in our experience, most important. The lymphoid tissue in the fossa of Rosenmuller is apt to be missed at operation as the surgeon is anxious to avoid excessive scarring in the region of the Eustachian tube. Just as in the case of the tonsillar

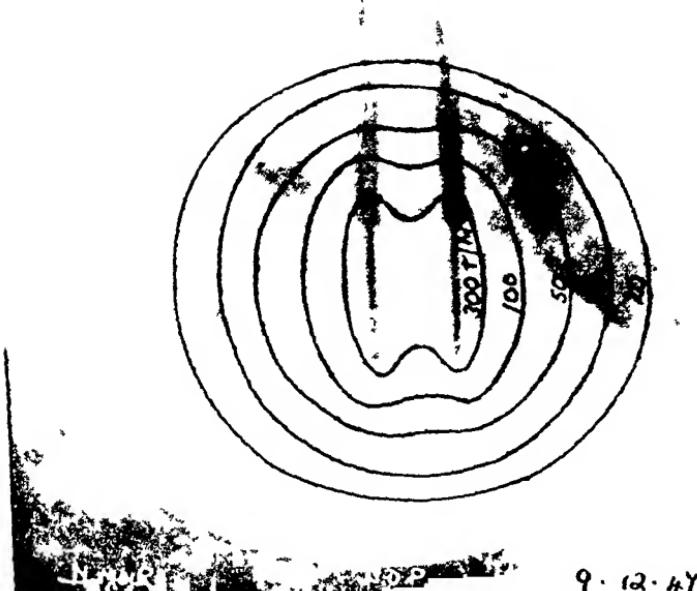


FIG. 1

X-ray of Nasopharynx in Vertico mental Projection with Applicators in situ, and Isodose curves superimposed

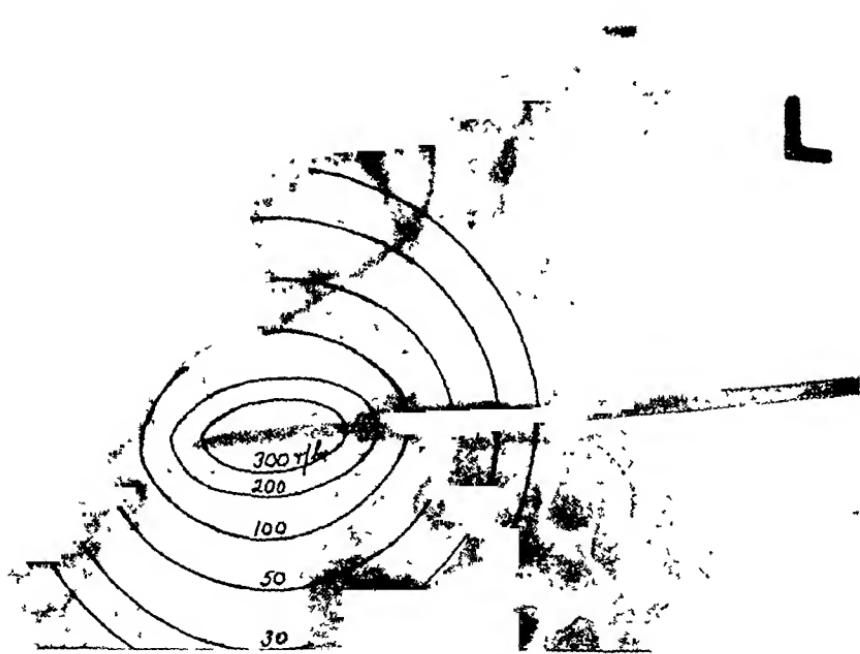


FIG. 2.

Lateral X-ray of Nasopharynx with Applicators in situ, and Isodose Curves superimposed.



FIG. 3
X-ray of Mucosal Hypertrophy of the Antra before Irradiation.



FIG 4
X-ray of Mucosal Hypertrophy of the Antra after Irradiation.

Nasopharyngeal Lymphoid Hypertrophy in Children

remnant, the adenoid tag readily becomes infected and hypertrophy occurs.

The rationale of radon therapy is based on limiting this hypertrophy and in making it an unsuitable medium for the growth of pathogenic organisms. To attempt to clear away all lymphoid tissue from the nasopharynx and Eustachian tube is, in our opinion, neither practical (as the lymphoid tissue extends along the length of the Eustachian tubes) nor is such a result desirable.

Akaiwa and Takeshima⁴ showed that irradiation caused a disintegration of the cell nuclei with inhibition of mitosis and decrease in the reproduction of lymphocytes within one hour of the commencement of treatment. We have attempted to adjust our dose so that it inhibits mitosis but does not cause much tissue destruction.

The smoothing out of the rather irregular lymphoid masses makes them less suitable sites for the growth of organisms. Since the effect of irradiation by ionization causes inhibition of mitosis in the tissue cells, it is reasonable to suggest that it will also cause attenuation of the bacteria present in the nasopharynx. If this were not the case, it would be difficult to explain the benefit that results, since the reduction in the hypertrophy of the lymphoid tissue is comparatively slight with the small dose which we use.

Technique

A glass capillary tube 3 cms. long containing 20 mcs. of radon was inserted in a platinum tube of wall thickness 0.5 mm. The platinum tube was then mounted in a brass holder which enabled it to be introduced through the nostril into the nasopharyngeal cavity.

One of these applicators was passed through each nostril in such a way that the radon containers lay parallel to each other and separated from the walls of the nasopharynx by a few millimetres at the nearest point. The applicators were then left in this position for one hour.

The platinum wall of the tube is sufficiently thick to absorb the β -rays almost completely and we may therefore treat the tube as a source of pure γ -radiation. The γ -ray dose delivered to points in the neighbourhood of the applicators can be calculated according to the standard methods used in radium dosage computation. From these calculations the position of the isodose surfaces are determined.

In Figs. 1 and 2, two sets of isodose curves have been superimposed on radiographs taken in two mutually perpendicular directions of the applicators in position.

Owing to the irregular shape of the nasopharynx the dose delivered to the surface is far from uniform, and to specify the dose at a particular point it is necessary to know the distance of that point from the applicators. A plaster cast of one typical nasopharynx was made and, when

used in conjunction with the radiographs, this cast enabled an estimate to be made of the distance of any point on the surface from the applicators.

For the particular case under consideration the Eustachian cushion was approximately 0.5 cm. from the nearer applicator and consequently the dose delivered in one hour in the neighbourhood of the cushion was about 300 r. At a depth of 1 cm. in the tissue the dose decreased to 70 r and at a depth of 2 cms. to 30 r.

Fowler describes a somewhat different method of treatment which has been used on a considerable number of patients. In this method a monel metal tube of length 1.5 cms. and wall thickness 0.3 mm. containing 50 mgm. of radium sulphate is placed in contact with the Eustachian cushion for six and two-thirds minutes. The β -rays are reduced in intensity on passage through the metal, but nevertheless the tube must be treated as a mixed source of β and γ -radiation.

The calculation of the dose delivered by a β -ray source presents some difficulty owing to lack of precise information on the absorption of β -rays in tissue. An estimate of the dose delivered by an applicator of the type described above has, however, been given by Fowler. If the tube is placed in contact with the tissue surface the dose delivered in six and two-third mins. at a depth of 1 mm. is 1520 r; at a depth of 1 cm. it is 55 r and at 2 cms. 15 r.

The dose delivered to the surface layers of the tissue by the monel metal applicator is therefore much higher than that delivered by the platinum applicator. On the other hand the dose delivered below the surface by the monel applicator decreases much more rapidly with increasing depth owing to the greater absorption of the β -ray component.

Dangers in Irradiation Therapy

The chief dangers which may arise from irradiation therapy are as follows:

1. Interference with centres of ossification. As has been demonstrated, the field of irradiation is very small and we consider this danger is only likely to arise if X-ray therapy is used.

2. Irradiation burns leading to scarring and occlusion of the Eustachian tubes. In the dose we have used, the risk of burning from the radon is negligible provided no attempt is made to bring the applicator into contact with the Eustachian tube itself.

3. Overdosage which may leave a wide and patulous Eustachian tube as an easy avenue for infection of the middle ear.

4. Reduction of activity of the ciliated epithelium in the nasopharynx. Heine⁵ investigated the effects of irradiation on ciliated epithelium and found that it withstood an unfiltered dose of X-rays three times that of the maximum for the skin of man.

We consider that all these dangers can be avoided by t

Nasopharyngeal Lymphoid Hypertrophy in Children

doses given at widely spaced intervals. We have judged our results more by the symptomatic improvement than by the decrease in the hypertrophy of lymphoid tissue.

Results

This form of therapy has been in operation for about three years. Considerably more than 41 patients have been treated but we have excluded all cases who have not attended for regular follow-up. In the majority of the patients X-rays of the maxillary sinuses have been taken before treatment. Where they have shown any radiological opacity or mucosal hypertrophy a further series of X-rays were taken at varying intervals after treatment. We have placed most reliance on the careful questioning of the parents as regards symptomatic improvement. In the analysis the cases have been split up into three groups; those treated for nasal catarrh, those treated for deafness, and a small group treated early in the series in which the tonsils and adenoids were not removed prior to irradiation as clinically they were small and did not appear to be grossly infected. The interval between the cessation of treatment and the last follow-up examination varied from eighteen months to two years.

I. NASAL CATARRH

Number treated	Mucosal Hypertrophy	Regression of Hypertrophy	Results	Number of Applications
24	22	18	Resolved 13 Improved 7 Failed 4	One 18 Two 6 Three —

II. DEAFNESS

Number treated	Mucosal Hypertrophy	Regression of Hypertrophy	Results	Number of Applications
11	7	3	Resolved 6 Improved 3 Failed 2	One 9 Two 2 Three —

III. TONSILS AND ADENOIDS NOT REMOVED

Number treated	Mucosal Hypertrophy	Regression of Hypertrophy	Results	Number of Applications
A Catarrh 5	5	2	Resolved 3 Improved 2 Failed —	One 4 Two 1 Three —
B Deafness 1	1	—	Resolved 1	One 1

Clinical Appearances and Findings

Examination of the post-nasal space was made by a small post-nasal mirror in the majority of cases, though, if necessary a nasopharyngoscope can be used. Most of the cases showed only slight decrease in the amount of lymphoid tissue though it did appear smoother in character. In 5 cases, however, the decrease was marked ; but only two of these patients had received more than one application. There was no evidence of any radiation 'burns' nor was there any scarring of the nasopharynx. In no case was any atrophic nasopharyngitis observed.

In the patients with deafness we found no stenosis of the Eustachian tubes and although there were two failures in neither of these was the patient's hearing made worse by treatment. We consider it probable that more frequent applications are necessary in the patient with catarrhal deafness and also that the dose given may require to be increased as a more marked reduction of the lymphoid hypertrophy is desirable than in the case with nasal catarrh.

Although some success attended the treatment by radon therapy of a small group of patients who had not had their tonsils and adenoids removed, the series is too small for the results to be of any real significance. If there is much enlargement of the adenoid tissue it should definitely be removed before radon therapy is tried.

Reactions to Irradiation

The parents of the patients who were treated some months ago were unable to recollect any flare-up of symptoms or other complications. In the more recent cases 3 had reactions. One had a sensation of stuffiness and fullness of the nasopharynx for a few days after treatment, possibly due to a coincident cold in the nose. Another had an acute flare-up of otorrhoea and was admitted for treatment. The ear soon settled down and has remained quiescent for the last two months. The third had a mild flare-up of otorrhoea which settled down rapidly with treatment at home.

Conclusions

The results we have obtained from radon application to lymphoid hypertrophy in the nasopharynx are, in our opinion, superior to any that we have achieved with the use of antral lavage, nasal drops, vitamin therapy or any other forms of treatment. Radon therapy caused considerable symptomatic improvement and no harmful effects were observed.

Summary

i. The results of radon applications to the nasopharynx in 41 children are presented and discussed.

Nasopharyngeal Lymphoid Hypertrophy in Children

2. It benefits two types of cases, chronic conduction deafness of Eustachian origin, and chronic nasal catarrh.
3. Tonsils and adenoids should be removed where necessary and the antra investigated, before irradiation is considered.
4. With the dosage used radon treatment of nasopharyngeal compensatory lymphoid hypertrophy is a safe and effective procedure.
5. Results are judged symptomatically and not by the regression of lymphoid tissue in the nasopharynx. The latter criterion can lead to over-treatment.

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MUCOCELES

By M. J. TAMARI and JAMES J. O'NEIL (Chicago, Illinois)

Introduction

ALTHOUGH otorhinolaryngological literature contains many cases of mucoceles since the condition was first reported in 1839, little has been written in recent years concerning the possible mechanism and pathology of this condition.

Since it has been our experience to see four cases during the past nine months in which a diagnosis of mucocele was made, we should like to very briefly report these cases, discuss their diagnosis and treatment, and on the basis of careful pathological studies present what we believe is a more understandable concept of the mechanism of mucocele formation.

Case No. 1

A 66-year-old white male was admitted to the Illinois Eye and Ear Infirmary on September 10th, 1947, with the following history: four years before he noted a small, painless swelling over the left eye, which became progressively larger causing a marked facial deformity, diminished vision, and a downward and outward displacement of the eye. No history of trauma or infection could be elicited and the past history for rhinological difficulties was non-contributory.

Ophthalmological findings consisted of: a cystic like swelling above and in the left orbit extending forward approximately one and one-half inches causing a downward and outward displacement of the eye. Vision was recorded as 20/200 in the left eye. There was no diplopia.

Otorhinolaryngological examination revealed no unusual findings. X-ray films of the skull revealed a destructive process involving the superior and medial portion of the left orbital ridge, the frontal sinus septum and upper medial angle of the right orbital ridge. The left anterior ethmoids appeared to be partially destroyed. On September 11th, a diagnostic aspiration of the cystic mass was made with about 5 c.c. of a brownish tenacious sero-sanguineous fluid being obtained. On the basis of the eye changes, diagnostic aspiration, and X-ray findings a diagnosis of mucocele was made.

On September 12th, an external frontal operation was performed and the mucocele removed. The floor of the frontal sinus, the medial wall, and the interfrontal septum had been completely destroyed. The posterior and lower wall of the frontal sinus had been eroded and an

Mucoceles

extradural abscess $1\frac{1}{2}$ cm. in circumference had formed. All possible necrotic debris was removed and the entire ethmoid labyrinth exenterated. A large drain was placed from the sinus into the nose and the skin closed.

The patient's postoperative course was uneventful.

Case No. 2

A 25-year-old negro male presented himself at the Illinois Eye and Ear Infirmary on April 28th, 1947, because he had noticed a drooping of the left eyelid during the past year.

He stated that in 1936 he sustained a fall on the ice cutting the skin over the left eyebrow, which required five stitches to close. In 1938, he fell off a street car and injured the left side of his head, but was not seriously incapacitated. No history of past rhinological difficulties, headaches, diplopia, or vertigo could be obtained.

Ophthalmological findings consisted of a sensation of fullness of the inner canthus of the left eye and vision of 20/40 for this eye. The remainder of their examination was normal except for a slight ptosis of the left lid and a downward and outward displacement of the left eye.

Otorhinolaryngological examination revealed no abnormal findings and the rhinoscopic picture in particular was normal. X-ray studies of the frontal sinuses revealed a depression of the superior margin of the left orbit consistent with a mucocele.

An external frontal operation was performed under local anaesthesia and the mucocele of the left frontal sinus was removed in its entirety, together with the entire mucous membrane and necrotic bone of the sinus. The naso-frontal ostium was enlarged and a rubber tube was placed from the sinus through the nose, after the anterior one-third of the middle turbinate had been removed.

The patient's postoperative course was uneventful.

Case No. 3

A 43-year-old negress presented herself at the Illinois Research Hospital on October 1st, 1947, because of a painfully protruding eyeball of six months' duration.

She stated that in April 1947 she had a severe cold followed by sinus trouble after which she noticed that her left eyeball began to protrude, her vision began to be impaired, and her eye motility limited.

Ophthalmological findings consisted of: a proptosis of the left eye to 25 mm. in a downward and outward direction with marked engorgement of the retinal veins. Disc margins were hazy suggesting oedema of the disc. Vision was recorded as 20/25 plus 3.

Otorhinolaryngological examination revealed a septal deviation to

M. J. Tamari and James J. O'Neil

the left with œdematosus mucosa of the turbinates but no pathological secretions. X-rays revealed destruction of the superior lateral margin of the left frontal sinus involving the roof of the left orbit. A roentgen diagnosis of osteomyelitis with bony destruction of the superior and lateral walls of the left frontal sinus and of the roof of the left orbit with left ethmoiditis was made. These findings together with the eye changes suggested a mucocele or pyocele of the frontal sinus.

On October 17th, 1947, a submucous resection with the removal of the anterior one-third of the middle turbinate was performed. Two weeks later an external frontal operation was done but no mucocele was found. The medial aspect of the sinus was soft and tissue was removed for biopsy. The naso-frontal ostium was enlarged and a rubber catheter sutured in place. The skin was closed.

The pathologist reported the biopsy material as Carcinoma.

The patient had a foul discharge from the wound postoperatively and by mid-January 1948 had become bed-ridden because of weakness and pain. On January 23rd, 1948, she was re-hospitalized and a radical exenteration of the left orbit with removal of a large part of the left frontal and ethmoid sinuses together with the zygoma and the great wing of the sphenoid was performed. The area was extensively involved by carcinoma with apparent extension to the dura. The wound was left open for postoperative X-ray therapy.

To date the patient has received extensive postoperative X-ray therapy and is being followed regularly in the Tumour Clinic.

Case No. 4

A 51-year-old white male presented himself at the Illinois Eye and Ear Infirmary on February 13th, 1948, because of pain over the right frontal and maxillary sinuses and dryness of the throat.

The otorhinolaryngological examination revealed a marked injection of the mucous membrane of the nose and pharynx. X-rays of the sinuses revealed a large rounded mass of slight increase in density within the right antrum with slight haziness of the right frontal sinus. A roentgen diagnosis of mucocele of the right antrum and a mild right frontal sinusitis was made. Lipiodol studies of the right antrum confirmed the diagnosis of mucocele.

On February 27th, 1948, a Caldwell-Luc was performed on the right antrum and the large mucocele was removed and sent to the laboratory for biopsy study. The patient's postoperative course was uneventful.

Diagnosis

From these cases it would appear that the diagnosis of a mucocele in the advanced case is simple, in the complicated, confusing, and in the early, extremely difficult.



FIG. 1
Showing front and side view before surgery.



FIG. 5.

Bony changes of the sinus wall with pressure necrosis and bone apposition.

Mucoceles

In most cases the patient is first seen by the ophthalmologist because of visual complaints and secondarily by the otolaryngologist.

The history generally given by the patient is one of diminished vision, diplopia, and a painless progressive displacement of the eye in a downward and outward direction. On further inquiry he may recall an injury to the head a number of years previously, or recount a history of a severe sinus infection in the past.

The otolaryngologist is presented with a case which must be differentiated from: gummas, aneurysm, fibromata, angioma, lymphoid tumours, meningoceles, carcinoma, osteoma, and xanthomatosis. A case with all of the classic findings of a mucocele has been reported in the literature which proved to be a case of xanthomatosis.

The otorhinolaryngological examination is very often unrevealing and the rhinoscopic examination in particular is generally normal. The otolaryngologist's suspicion may be aroused by a parchment-like crackling due to the partial absorption of the bone. His chief armamentarium, however, consists in a diagnostic aspiration, which if positive for thick brownish tenacious fluid is presumptive evidence of mucocele, and the X-ray, which shows destruction of bone, and in the absence of other findings can be interpreted as additional evidence of mucocele. Even after a tentative diagnosis of mucocele has been made, measures should be taken to insure an immediate frozen-section pathological study at the time of surgery in the event that a malignancy is encountered.

Treatment

On the basis of the operative findings in the cases of this series together with the extensive pathological changes to be mentioned below, it seems to us that the only adequate therapeutic measure lies in a radical exenteration through an external incision combined with the establishment of adequate intranasal drainage. Intranasal procedures alone as advocated by Goodyear are inadequate except when radiological findings are negative and the bone is intact.

The intranasal procedure has been found to be temporizing with a serious condition and in two cases observed by us has led to a recurrence of the mucocele.

The external operation should be made through the Killian incision for mucoceles of the frontal sinus. The technique advised by Lederer of making the incision through the line of the eyebrow growth, which is clipped preoperatively, has been found to enhance the postoperative appearance of the patient, making the line of incision almost imperceptible. Following the removal of the mucocele from the frontal sinus, the cavity should be radically exenterated of all suspicious membrane and the ethmoid sinuses should be thoroughly curetted.

The external operation for mucoceles of the maxillary sinus should

M. J. Tamari and James J. O'Neil

consist of a well-executed Caldwell-Luc procedure. The formation of an antral window in surgery for this condition is optional.

The Mechanism of Mucocele

At the present time the mechanism of mucocele formation is believed to be a cystic accumulation of fluid, resulting from either trauma or infection, which undergoes active enlargement within a sinus causing atrophy of the surrounding bony structure. On the basis of a careful study of sections obtained from the four cases presented above we should like to advance another concept for the explanation of mucocele formation.

Pathological specimens, upon which this new concept is based, lead us to believe that initially there is a submucosal injury, either haemorrhage caused by trauma or as a result of an invading infection, which causes a localized elevation of the mucosa. It will be apparent that, in contrast to the other theories, this elevated mucosa forms the beginning wall of the future mucocele and by the herniation of the mucosa toward the cavity of the sinus as gradual development occurs by the accumulation of its contents, the wall of the mucocele is going to consist outwardly of the pseudostratified columnar ciliated epithelium and inwardly of fibrous connective tissue which has been stripped away from the endosteum. Because of the resistance offered by the sinus mucosa to this submucosal elevation, the progress and development of the mucocele is a rather slow one. When the elevated and herniated mucosa finally touches the intact sinus mucosa of one of the surrounding sinus walls and the submucosal distension persists pressure is exerted upon both the mucosa and the underlying bone. This explains the history of trauma sustained many years previously which is elicited from patients who have the characteristic visual signs and symptoms of mucocele. Indeed the trauma may have occurred so long before that the patient cannot recall the incident.

To recapitulate, the main points in the mechanism of mucocele formation seem to be: (1) A submucosal injury either haemorrhagic, traumatic, or infectious; (2) an elevation of the mucosa caused by an accumulation of exudate beneath it; (3) a herniation of the elevated mucosa toward the centre of the sinus cavity; and (4) pressure of the herniated mass upon normal sinus mucosa and the underlying bone.

The Pathology of Mucoceles

The histo-pathology of mucoceles as revealed by the specimens of our series may be considered under three parts: (1) Contents; (2) Mucosal changes; and (3) Bone changes.

The contents of the mucoceles consist chiefly of old blood elements, accumulations of red blood cells, red cells suspended in serous fluid,

Mucoceles

fibrous elements, and large cells. Significantly, there are no cholesterol crystals present. It is known that cholesterol crystals are found in cysts derived from ectoderm such as dental cysts, but are absent from growths arising from mesoderm and are thus absent in mucoceles.

The external mucosal changes consist primarily in a modification of the normal sinus mucosa. The normal cilia are absent and the columnar cells become cuboidal in type as a result of the pressure exerted by the developing mucocele.

The inner wall of the mucocele is considerably thicker at the base where the initial submucosal injury resulted in an elevation and herniation of the sinus mucosa. It becomes thinner as the mucocele enlarges and contacts the osseous walls of the sinus. Microscopically the wall consists of an internal fibrous layer and an external layer of epithelium with the changes mentioned above.

Grossly, the mucocele appears bluish if the contents are brown and pale if the contents are colourless.

The changes of the adjacent bone are those characteristic of bones influenced by constant pressure and tension. In the beginning of the process, the pressure stimulates bone apposition and leads later, with an increase of pressure, to bone resorption which prevails above the first changes, giving the bone a thin parchment-like appearance.

In microscopic sections one can see the endosteum replaced by a loose fibrous membrane infiltrated with necrotic bone cells and blood cells. The surface of the bone shows areas of recent absorption with osteoclastic activity and apposition of a new immature bone. The marrow tissue spaces in the deeper areas are transformed to fibrous tissue cavities with an active bone absorption.

The external bony lamina appears to be affected by the pathologic changes of the inner surface. One can see areas of a very recent reconstruction with active bone apposition under the thickened periosteum. The circumferential lamellae underneath the periosteum show a dense area of reversal and resting lines interrupted by a few old Haversian systems. The marrow tissue spaces and Haversian canals are enlarged and partly filled with fibrous elements. The lacunae of the lamella are empty because of the absence of the osteocytes.

Signs of inflammation and cellular infiltration are not visible and the entire process seems to be the result of a metabolic and physical alteration rather than one of an inflammatory osteitis.

Summary and Conclusion

We have presented four cases in which a diagnosis of mucocele had been made in our clinics within a nine month period. We have reviewed very briefly the symptomatology, the problems of diagnosis, and the manner in which we feel such conditions should be adequately treated.

M. J. Tamari and James J. O'Neil

On the evidence gained from a careful pathological study of the material from these cases, we feel that a mucocele is not due either to cyst formation in the lining membrane of the sinus or to the blocking of the sinus ostium. On the strength of this evidence we have presented what we believe to be a new concept in the mechanism of mucocele formation, namely: (1) a submucosal injury occurs as a result of traumatic haemorrhage or infection, resulting in (2) an elevation of the mucosa with an accumulation of exudate beneath it; and that (3) a herniation of this elevated mucosa occurs until it encounters the resistance of normal sinus mucosa of one of the sinus walls where (4) pressure is exerted upon the mucosa and the underlying bone producing characteristic changes.

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FIG. 1.



FIG. 2.

CLINICAL RECORDS

A CASE OF NASOPHARYNGEAL CHORDOMA

By A. S. HANDOUSA BEY (Cairo, Egypt.)

CHORDOMATA are rare growths met with in relation to the body axis, and believed to arise from the vestigial remnants of the notochord. They mainly develop in relation to the spheno-occipital and the sacro-coccygeal regions. According to Wakely,¹ analysis of the cases reported in the literature shows that 60 per cent. occur in the spheno-occipital region. Instances of these growths are also well known to be met with in the pharynx among other sites in relation to the spine. Thus chordomata are met with in the domain of the rhino-laryngologist much more than anywhere else. Although known to present no reliable diagnostic clinical or radiological features, these tumours have almost always been described to have a *tense jelly-like feel*. The following briefly detailed report of a spheno-occipital chordoma is of interest as it felt bony hard.

F.F., female, 16 years old complained of complete nasal obstruction for $2\frac{1}{2}$ years. This started in the left side, and gradually increased until the obstruction on both sides of the nose was complete. The patient during this period of time was under treatment somewhere else, and apparently examination of the nasopharynx was missed as she was believed to be suffering from sinusitis. She was subject to vague headaches, but there was no associated epistaxis or any history suggestive of specific disease.

On examination, the patient was anaemic and feeble. The nasal mucosa was congested, and narrowing the air passages, but there were no visible polypi or tumour masses on anterior rhinoscopy. Only the left antrum was opaque on transillumination. Posterior rhinoscopy revealed a large mass attached by a very wide base to the roof of the nasopharynx and completely obstructing the post-nasal space. This mass looked smooth, uniformly rounded, and covered by intact healthy-looking mucosa ; on feel it was bony hard all over.

Apart from slight granular pharyngitis, the pharynx, larynx, buccal cavity and ears showed no abnormality.

Further investigations revealed no visual or orbital affection ; no other tumours were found in the course of the vertebral column whether in the neck or in the sacro-coccygeal region. Central nervous system examination was made too, with normal findings.

Radiologically, several films were made by Dr. N. Abou-Saif in different positions, in attempt to define the extent of the tumour, and the bones to which it is related, and if possible its nature. Four films are shown here.

Figs. 1 and 2 diagrammatically represented in 3 and 4 show an ovoid, well limited shadow of the tumour in relation to the base of the skull filling the cavity of the nasopharynx.

The shadow arises from the basi-occiput, basi-sphenoid and extends forwards in relation to the antero-inferior wall of the sphenoid sinuses. It also extends laterally almost to the foramen ovale on each side.

All films prove the absence of intracranial extension of the tumour.

The previous findings prove that the cause of the nasal obstruction complained of, was a growth arising from the spheno-occipital region, neither in the nature of a nasopharyngeal fibroma as it felt bony hard, nor in the nature of an osteoma as the radiological appearances are against. Fig. 6 is a view of the tumour taken 3 months after Fig. 5; comparison of both shows that the tumour mass is undergoing degeneration; this finding again is against osteoma.

In spite of the long history and large size of the growth, there was no ulceration or secondary metastasis; so it seemed probable that this growth

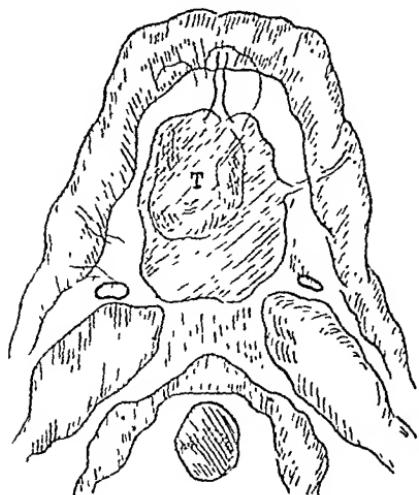


FIG. 3.



FIG. 4.

T—Tumour.

was benign (chordoma?) or of low malignancy (osteoclastoma?). The usual teaching that a chordoma has a tense jelly feel, clinically excluded this possibility, too. It was impossible to arrive at a definite diagnosis without biopsy, and I decided to try to remove the tumour and examine it histologically.

A *preliminary tracheotomy* was first performed as it serves for the purpose of administering the anaesthetic, and allows of packing the pharynx to avoid aspiration of blood during the operation. The tumour was then exposed from the front by the *left lateral rhinotomy* route.

After incising the covering mucosa about the centre of the mass and turning the flaps laterally, the anterior part of the tumour came into view. It felt also hard all over. By the buccal route a periosteum elevator was forced in between the posterior end of the tumour and the base of the skull under the stripped mucosa; and by working with the periosteum elevator laterally and forwards, the tumour was mobilized and removed. The site of attachment was bimanually examined *via* the buccal and lateral rhinotomy routes, and



FIG. 5.

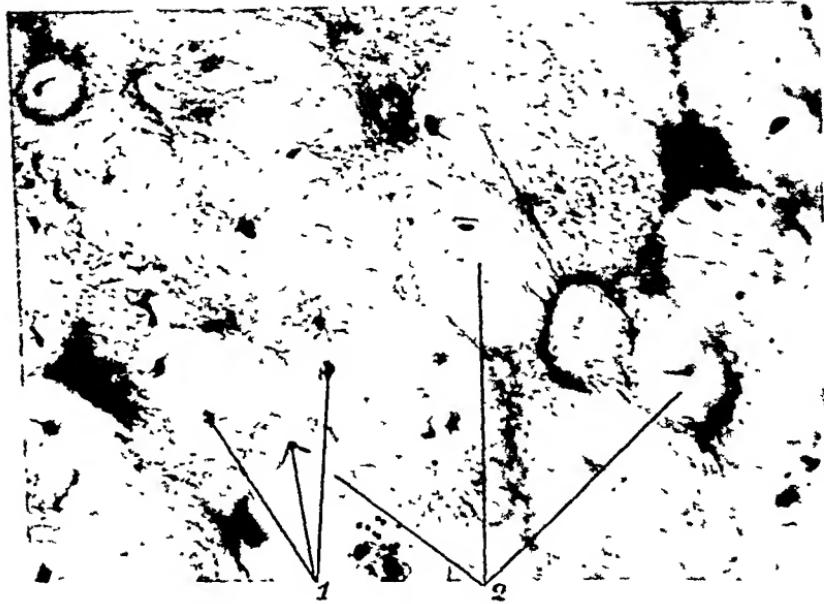


FIG. 7
CHORDOMA

1. The cartilage like cells with shrunken irregular protoplasm halos around the cells 2. The degenerated



FIG 8
CHORDOMA

- 1 Bone trabeculae outside the tumour 2 Myxomatous fatty tissue between bone trabeculae 3 Aggregations of septic inflammatory cells

Clinical Records

all the rough areas were scraped out and smoothed down by a curette at the end of the operation.

There was no unusual bleeding, but during mobilization the mass was broken up with a flow of a fairly large amount of thick blood-stained fluid.

The raw surface left after removal of the tumour was packed with flaxen vaseline gauze, and the lateral rhinotomy wound was closed.

The tumour mass removed, was then examined and found to be made up of a shell of bone 2 mms. thick, containing soft friable tissue.

The nasopharyngeal pack was removed after 24 hours and the tracheotomy tube was removed one day later. Recovery was uninterrupted and the patient is being regularly examined for two years and so far without any sign of recurrence.

Biopsy was performed by Professor Sorour Bey with the following report.

Sections from the basi-sphenoid tumour sent to us showed a picture suggestive of chordoma. The tumour tissue is rather degenerated. Some bony tissues were found in relation to the tumour masses. There is no evidence of osteoclastoma nor of any other malignant growth. The tumour tissue has got a homogeneous matrix with scanty cells scattered in it. The cells vary in shape and in size and have some resemblance to cartilage cells. Very often the cells with their shrunken, irregular protoplasm, are surrounded by an apparently empty halo. The protoplasm of some cells is often stellate in form. The thin bony trabeculae seen in sections related to the tumour tissue are separated by a moderately thin walled vascular fatty, myxomatous tissue. There is evidence of sepsis in fibrous tissue pieces related to the tumour tissue.

Figs. 7 and 8 are microphotographs of the histological appearances.

I am indebted to Professor Sorour Bey for his personal care and examination of the histology of this case; and Dr. N. Abou-Saif who studied it radiologically.

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A CASE OF NON-METALLIC FOREIGN BODY IN THE ETHMOIDAL SINUS

By H. C. P. GUNEWARDENE (Ceylon)*

VERY few cases are reported in the literature of foreign bodies in the paranasal sinuses. Even the war literature has few references to the presence of metallic foreign bodies in this situation. Every case of a non-metallic foreign body is of great interest. The case here reported shows that a fistula persisting after the removal of a foreign body is most likely to be due to incomplete removal, as suggested by Thornell,¹ though osteomyelitis cannot be excluded. That Roentgenograms are of no value in demonstrating the presence of a non-metallic foreign body has been stressed by Thornell¹ and Cantoni.² It is impossible to locate accurately the exact site of a non-metallic foreign body before operation.

Voorhees³ reported a case of a metallic foreign body inside the nasal chamber. Subba Rao's⁴ case from the Victoria Hospital, Bangalore, was that of a tamarind seed in a child, which had ulcerated the lateral nasal wall and was ultimately found in the antrum. Apparently a coating of calcium had prevented the seed from germinating. Cantoni² who recently removed pieces of a pencil from the nasal chamber of a negro patient in the University of California Hospital, was able to see the foreign body like a rhinolith in the nose. Thornell's¹ case was that of a child aged 3 years, which fell on a branch of a tree; a piece of wood was removed from the floor of the orbit and the posterior ethmoidal cells. In the roof of the antrum was a sequestrum which was removed at the same time.

R. Sarpin, a male aged 16, was admitted to the General Hospital, Colombo, Ceylon, on *July 11th, 1946* because of inability to open the mouth freely, weakness of the left arm, and an ulcer in the right cornea. He gave a history of diving into a stream three months before, when a spike from the river-bed entered his face and broke off. He was taken to a nearby hospital, and a piece of wood was extracted from the wound. Since then he could not hear with his right ear, and the face became asymmetrical.

Though he left hospital a few days later, the deafness and the facial condition persisted, and there was a discharging sinus below the right eye.

Two months after his accident the left side of his body became weaker, particularly the left arm.

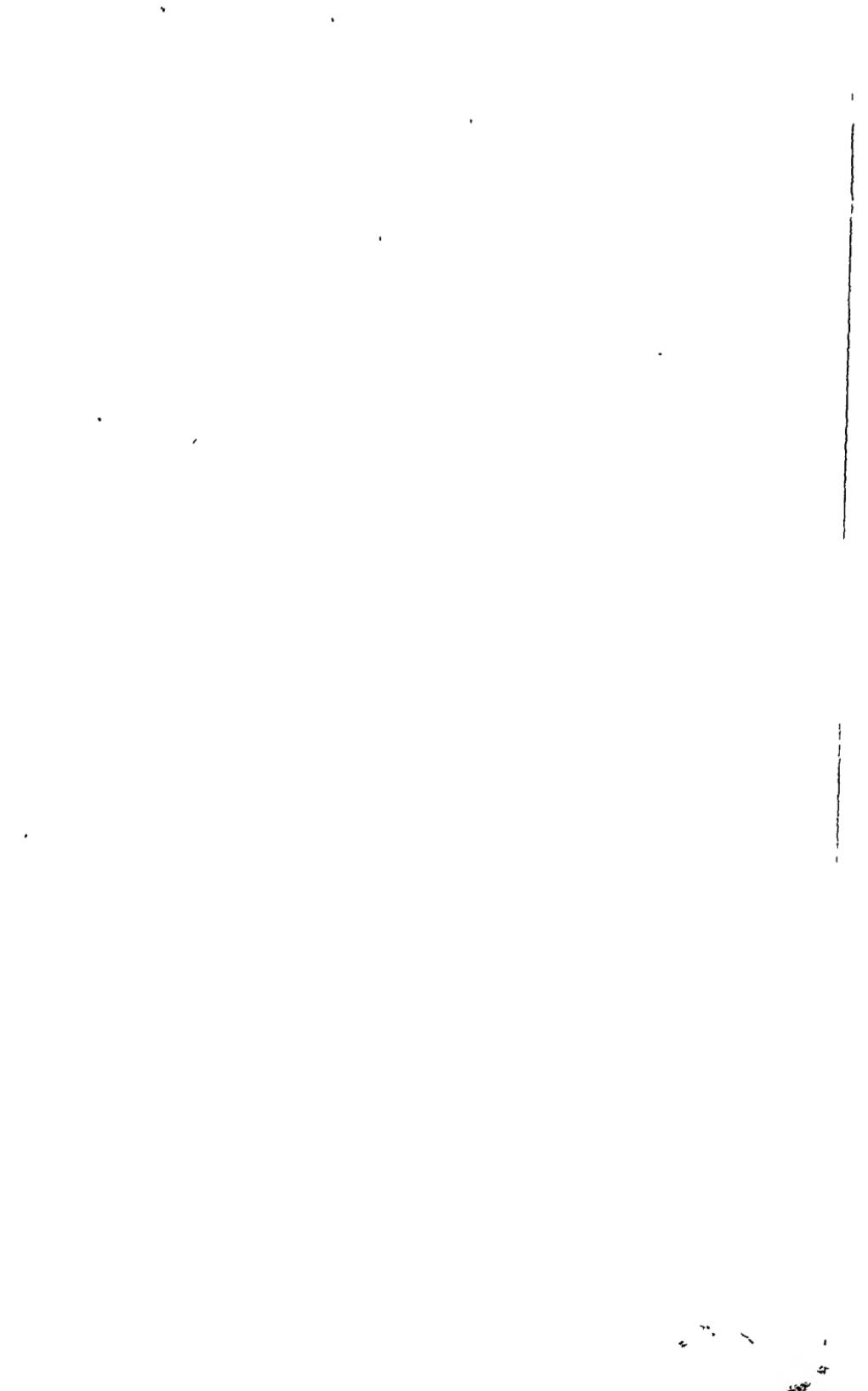
On examination there was right-sided facial paralysis of the lower motor neurone type (Fig. 1), right-sided total nerve deafness, and inability to raise the left arm beyond 30° from the body. There was a sinus immediately below the right eye, the entrance to which was covered with pouting granulations, with thin sero-purulent discharge. The boy had a low fever (100° F.) in the evenings. Auroscopic examination showed the drums normal in appearance.

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FIG. 1

The Right-sided facial palsy and the fistula below the eye. To the right is shown the piece of wood that was removed from the ethmoid capsule and its length.



Clinical Records

Blood Wassermann and Kahn were negative. Vision in right eye 6/36. The corneal ulcer was due to imperfect closure of right eye-lids, other eye muscles working normally. Four days after admission the patient complained of giddiness and anorexia, and had nausea and vomiting. X-ray showed an opacity of the right maxillary antrum, but no foreign body could be seen.

Operation on August 9th, 1946.

The right maxillary antrum was opened through the upper alveolo-labial fold. There was a small quantity of pus, but no thickening of the mucous membrane. As the appearances were insufficient to account for any disease of the antrum or orbital floor, the ethmoidal cells were opened. Here a hard object was encountered, fixed lengthwise in the ethmoidal labyrinth. This was gradually levered out through the antrum. It was found to be a piece of wood as shown in Fig. 1. The cells of the ethmoid were opened up and cleaned, and the wound in the lip was closed without drainage. The sinus below the eye was curetted. The patient's convalescence was uneventful. On the third day after the operation he was able to raise his arm above the shoulder, and its power steadily grew. The loss of hearing and the facial paralysis have remained.

The boy was discharged on September 10th, 1946. Re-examination on April 5th, 1948; he is earning his living as a cook, although he is deaf in the right ear and has right-sided facial palsy. Movements and power of his limbs are normal.

Summary

1. A case of non-metallic foreign body in the ethmoidal labyrinth is reported.
2. Extensive nerve lesions were present, produced partly by injury at the time of the accident and partly by subsequent localized infection.
3. Persistence of a sinus after apparent removal of a foreign body is most likely due to leaving a piece behind.
4. X-rays are valueless in demonstrating a non-metallic foreign body in this region.
5. When the foreign body is removed, convalescence is uneventful, and there is total recovery from symptoms which are due to concomitant infection.

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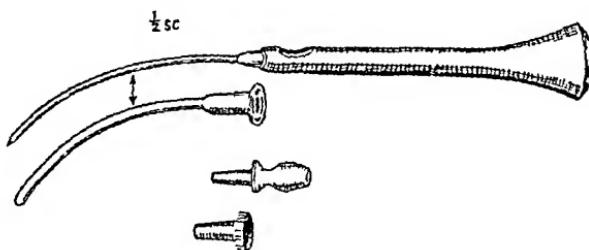
CLINICAL NOTE

TREATMENT OF MAXILLARY SINUSITIS BY INSTILLATION OF PENICILLIN

By ALFRED WALFORD (Cambridge)

MANY cases of acute maxillary antritis require no operative interference. But some of these, and most cases of subacute and chronic infection, will not settle without some form of surgery. Present opinion is in favour of leaving undamaged the mucosa and preserving as far as possible the normal anatomy.

Instead of repeated antral puncture, which is unpleasant for the patient, and not always successful, a curved canula is inserted into the antrum and left



in situ for five days. Twice daily through this the antrum is aspirated and well washed out with normal saline. The saline is displaced by a syringe full of air and 150,000 units of Penicillin in 3 c.c. of glycerine of Tragacanth introduced. The outer end of the canula is then closed with a metal bung.

Both antra can be treated at once, but strict aseptic technique for the aspirations and instillation must be observed, which generally necessitates hospitalization, although there is no need to confine the patient to bed.

This method of treatment is generally well tolerated by both adults and children, and in acute and subacute cases is, I think more often successful than the older methods.

A number of cases of chronic maxillary antritis also appear to have cleared, especially those with a purulent discharge, but it is too early to draw conclusions as to these results, and on general principles it would seem unlikely that this treatment would effect a cure in chronic cases, where there is already much mucosal change.

Messrs. Mayer & Phelps have made for me a modification of Mr. N. Asherson's antrum intubation canula. By curving the canula, and having two different sizes, it has been found possible to insert and leave them in situ in both children and adults without the pain or discomfort caused by the straight type, which so often exerts pressure on the septum.

The canulae are fixed in position by means of short tapes which are strapped to the face.

SOCIETIES' PROCEEDINGS

NORTH OF ENGLAND OTOLARYNGOLOGICAL SOCIETY*

THE Fifth Meeting of the North of England Otolaryngological Society was held at the Victoria Hospital, Blackpool, on Saturday, June 5th, 1948, Mr. G. E. ARCHÉR of Manchester presiding.

Thirty cases were presented by Mr. I. B. Thorburn and Mr. A. Finlay Brown.

Cases 1 to 14, were presented by Mr. I. B. Thorburn to illustrate the employment of the Lempert endaural technic in the surgery of the temporal bone.

Cases 1 and 2, epitympano-mastoidectomy for the relief of attic disease with conservation of hearing.

Cases 3 and 4, subcortical mastoido-tympanectomy for the control of chronic middle-ear and mastoid suppuration.

Cases 5 and 6, subcortical mastoido-tympanectomy with complete healing. There had been persistent discharge from hypotympanic and peritubal disease following a previous radical mastoid operation.

Case 7, decompression of the facial nerve in a case of Bell's paralysis.

CLINICAL SUMMARY

Male, aet 62. Left facial paralysis 11 weeks duration. Initial pain left side of head. No herpes reported. Severe deafness in left ear since he had Ménière's disease 25-30 years beforehand.

Examination left ear. M.T. normal. Hears R.V.3* (masking right ear.)

Vestibular reaction active.

Loss of taste left side of tongue.

Reaction of degeneration present in all segments of left facial nerve.

12.4.48. Operation by endaural route. Facial nerve exposed in tympanic and mastoid portions. No lesion of the nerve observed under 8 x magnification.

12.5.48. Paralysis unchanged.

4.6.48. Brisk galvanic response. Faradic response present in middle group of facial muscles.

Cases 8 to 14. Seven illustrative cases of clinical otosclerosis treated by the fenestration operation.

The detailed notes of investigation, operation and follow-up of 20 consecutive cases treated by the fenestration operation between July 1947 and January 1948 were also presented.

Cases 15 and 16 were shown by Mr. A. Finlay Brown as a contrast to the above series: one had a modified radical and the other a complete radical

* A decision to commence publishing transactions of the Society was only reached after the meeting, so that a detailed note of the discussion at this meeting is not available.

Societies' Proceedings

mastoid operation carried out by the endaural route using the usual hammer and gouge technic.

DISCUSSION

THE PRESIDENT remarked that following the recent lecture and demonstration by Dr. Julius Lempert at the Royal Society of Medicine, it was appropriate that Mr. Thorburn, who was a trainee of Dr. Lempert, should present this interesting series of cases.

In reply to a question by MR. GEORGE SEED about the after-care of the operation cavity, Mr. Thorburn stated that his routine was to mop out the cavity with 1 per cent. C.T.A.B. (Cetavlon) solution, dry with cotton tipped probes, paint any raw surface with 2 per cent. aqueous solution Gentian violet, and insufflate either 1 per cent. iodine in boracic powder or penicillin sulfathiazole powder. Granulations had sometimes to be removed or cauterized with trichloracetic acid.

MR. F. MCGUCKIN and MR. I. A. TUMARKIN, with regard to Case No. 7, expressed the opinion that the facial paralysis and the reaction of degeneration could well have been due to a virus infection of the geniculate ganglion. This could occur without the presence of observable herpes as in the complete syndrome of herpes zoster oticus, and decompression of the nerve in their opinion did not seem to be rational treatment.

Mr. Thorburn, in reply, stated that he had not considered a virus infection as a likely cause of the paralysis in this case, but had followed the experience of Cawthorne in accepting the presence of a reaction of degeneration as a sufficient indication for operation.

Cases 17, 18 and 19. Mr. A. Finlay Brown. Injection of the inferior turbinates with 5 per cent. Phenol in almond oil for the relief of obstructive turbinal oedema in chronic allergic rhinitis. Mr. Brown remarked that the treatment was easy to carry out and had brought marked symptomatic relief in each case. In one case, presented, a boy aet 15, additional severe asthma had also been greatly relieved.

Carcinoma of the Larynx—Cases XX-XXIV—MR. I. B. THORBURN.

(XX)

Mrs. M.H., aet 66. This patient was under observation for 5 years from 1942 to 1947 with keratosis laryngis. Her only complaint was of hoarseness which had been constantly present since 1938. Biopsies of the larynx taken in 1942 showed an active inflammatory hyperplasia but no malignant change. When examined in October 1947 there was some laryngeal stridor and a fresh biopsy showed multi-focal carcinomatous changes. On 3.12.47 an emergency tracheotomy was required. On 30.1.48 the larynx was removed using the Chevalier Jackson narrow field technic. The larynx was examined by Dr. F. Yates, Pathologist to the Victoria Hospital, who reports:

Macroscopically the vocal cord on each side was thickened and whitish. A vertical section was taken through the true and false cords on the right side, at about the middle of their length, after splitting the larynx posteriorly.

Microscopically the squamous epithelium covering the vocal cord shows epitheliomatous change and its more superficial part has been shed. It

North of England Otolaryngological Society

invades the corium in the form of narrow columns of cells which are moderately well differentiated and show some attempt at keratinization. Commencing invasion of the muscle is seen but in the plane of the section it is only very superficial. The character of the cells suggest that the process is of slowly growing type. There is no evidence of spread into the ventricle.

On the review of the earlier biopsies in 1942 Dr. Yates was of the opinion that these sections also showed early malignant changes. Larynx and microscopic changes were exhibited.

(XXI)

Mr. L.I., schoolmaster, aet 60. Complained of hoarseness for two years prior to operation. When first examined on 15.11.45 there was restricted movement of the left vocal cord but no induration. The patient failed to report for observation as requested but returned in *August 1947*, when ulceration was observed above the anterior commissure involving the cushion of the epiglottis and spreading over the anterior third of the right vocal cord. The left vocal cord remained fixed but of healthy appearance, whereas the right vocal cord moved freely. A biopsy was taken and reported as squamous carcinoma, the cells varying from poorly differentiated to highly keratinized types. On 19.9.47 the larynx was removed using the Chevalier Jackson narrow field technic and including the removal of the body of the hyoid bone and the pre-epiglottic space. The patient is now leading an active life. He has failed to develop an oesophageal voice but has a clear whisper and states that he has no difficulty in making himself understood. The larynx was exhibited.

(XXII)

Mr. A.B., aet 60. First seen 11.3.48 complaining of hoarseness of 18 months duration. Infiltration observed of anterior two-thirds left vocal cord, reaching but not crossing the anterior commissure. Movement not materially impaired. Direct laryngoscopy and biopsy; subglottic extent estimated at 3 mms. Biopsy report: squamous carcinoma. 19.3.48: laryngofissure, removing whole of left cord and anterior third of right cord. Subglottic extent reached depth of 1 cm. and only a narrow healthy margin was secured. A small gland was removed from cricothyroid membrane which on later histological examination was found to contain a single tumour embolus.

(XXIII)

H.J., aet 56. First seen 3.7.46 complaining of hoarseness of three years duration. Larynx showed generalized hypertrophic mucosal changes. Blood Kahn test negative. X-ray chest normal. Direct laryngoscopy and biopsy was carried out three times in the ensuing six months, with a biopsy report of inflammatory infiltration but no malignancy. A fourth biopsy on 25.7.47 was reported as squamous cell carcinoma. The local appearances of the larynx were unchanged and the movement of vocal cords good. The patient was treated during *September 1947* at Christie Hospital, Manchester, by beam directed small field X-ray therapy. Tumour dose = 5,500 r. There was considerable reaction following treatment with marked oedema of the larynx.

Societies' Proceedings

and neck. The reaction had partially subsided after three months, but during the past two months there has been increasing dyspnoea. There is marked epilaryngeal oedema and it is now likely that a tracheotomy will be required.

(XXIV)

T.T., aet 62. First seen 27.8.47 complaining of hoarseness of two years duration and commencing slight dysphagia. There was infiltration and fixation of the whole extent of right vocal cord and ventricular band. Biopsy showed a well differentiated squamous carcinoma. Laryngectomy was advised but refused. He received treatment at Christie Hospital during *October* by beam direct small field X-ray therapy: tumour dose 5,500 r. He was not seen again until 19.5.48 when he reported marked improvement for six months after treatment, but increasing dyspnoea, dysphagia and hoarseness in preceding two months. There was marked oedema of the larynx, especially posteriorly where it extended to the hypopharynx. Respiration was badly obstructed. On 24.5.48 a tracheotomy was carried out and feeding started by an oesophageal tube.

DISCUSSION

MR. THORBURN remarked that what impressed him most forcibly was the contrast between the comfortable, well-nourished and cheerful condition of the two patients treated by laryngectomy and the miserable cachectic state of the other two treated at about the same time by X-ray therapy. The unfortunate course in Cases 23 and 24 appeared to be due to delayed cartilage necrosis or perichondritis rather than to an extension of the disease. Up till recently he has thought of laryngectomy as a mutilative procedure likely to interfere seriously with the patient's enjoyment of living, but he has found that both these patients, having once appreciated the need for the operation, the limitations it imposed, and the possibility of any alternative speech mechanism, co-operated well and were amongst the most cheerful patients he encountered in his practice.

MR. J. H. OTTY remarked that perichondritis and cartilage necrosis, as in Cases 23 and 24, was a fairly common and distressing occurrence after radical X-ray therapy for carcinoma of the larynx. He thought that laryngectomy should now be carried out in each case and was the only way to make them comfortable.

MR. H. P. LAWSON remarked that he had seen Mr. Thorburn's two cases of laryngectomy and also the two cases of laryngeal carcinoma treated by X-ray therapy at the Christie Hospital. He agreed with the previous speakers that while the former are cheerful and optimistic, the latter are distressed and in pain with poor voices, and generally cast down, but before concluding that X-ray therapy is unsatisfactory and should be discarded in favour of radical surgery, there are several factors to take into account. Firstly, assuming a case is considered suitable for Ray therapy or laryngectomy, most patients will elect to have the Ray therapy in the hope that the voice will be preserved, and this is understandable; also a laryngectomy can nearly always be carried out later if necessary, and although more difficult technically, this is not a matter of great moment. The disposition and outlook of the patient must be considered, as after operation a good deal depends on morale; a depressed

North of England Otolaryngological Society

introspective patient, or one of low intelligence, will not do well with an artificial larynx.

If the carcinoma involves the middle third, or just slightly more of a mobile cord, the Finzi-Harmer operation is ideal: although the dosage of Radium is quite empirical in this operation the end results are far superior to that of any other treatment. Unfortunately, if the cord is not mobile and the neoplasm extends towards the ends of the cord, it is not considered at present that Radium needles used in the Finzi-Harmer manner is a satisfactory treatment, but at the Christie Hospital we have carried out a modified Finzi-Harmer operation with two needles round the anterior angle of the thyroid cartilage for a neoplasm that extends towards the anterior end of the cord, and so far the results have been good.

With regard to more extensive growths confined to the cords, but extending outside the middle third, Contact X-ray technique (Chaoul modified by Lambert) is satisfactory, but is usually followed by a variable period of oedema and some distress, as is also the beam X-ray for neoplasms of a more extensive type. It is the two latter types where laryngectomy as an alternative is to be considered. Here a most important point arises. Are there any palpable cervical glands? If so, a single or double block dissection neck must be undertaken in conjunction with the laryngectomy, or in association with the X-ray therapy. No laryngectomy should be undertaken when, if necessary, a block dissection of the glands of the neck cannot be carried out.

External Frontal Sinus Operations. Cases XXV-XXVIII

(XXV). MR. A. FINLAY BROWN.

Miss A.J.Y., aet 75. Admitted 9.2.48. History of head cold a week before followed by severe pain over the right eye and forehead. Marked proptosis and downward displacement of right eye: pupil fixed with loss of vision. No infection apparent in the nose, nor on intranasal exploration of frontal, sphenoid or ethmoid sinuses. X-ray showed a large right frontal sinus with medial opacity and a very thin floor.

16.2.48. Exploratory external frontal sinus operation. Large haematoma in superior peri-orbital space tracking into the orbital space. The floor of the frontal sinus was paper thin and was removed. The sinus mucosa was healthy but the cavity contained a large quantity of inspissated pus. The fronto-nasal duct was patent and was not disturbed. Penicillin tube inserted and wound closed. Following operation the proptosis subsided quickly. Vision has remained poor. She has remained very well.

Case XXVI. MR. I. B. THORBURN.

Mrs. M.C., aet 26. Admitted 18.3.48 with acute right sided pansinusitis of five days duration. Marked oedema over right frontal sinus and upper eyelid. No proptosis. Toxic nerve deafness. Fine rubber tubes were introduced to frontal and maxillary sinuses, through which the sinuses were washed out daily and local penicillin introduced six-hourly. Systemic penicillin 50,000 units three-hourly. Bacteriology: staphylococcus aureus, coagulase positive and sensitive to penicillin.

27.3.48. Patient very fit. Still thick pus from antrum.

Societies' Proceedings

Operation : right intranasal antrostomy.

10.4.48. Right antrum clean. No pus in nose. Oedema spreading over anterior wall frontal sinus.

Operation : radical external ablation of right frontal sinus and ethmoidectomy. Bone removal by electrically driven cutting burs so avoiding need to extend skin incision above eyebrow level. Area of osteomyelitis found beyond upper margin of sinus and further bone removal exposed a large extradural abscess. Wound closed without external drainage.

24.4.48. Complete healing. Allowed home.

10.5.48. No oedema. Nose free of pus. Depression deformity very slight.

Case XXVII. MR. I. B. THORBURN.

Mr. G.R., aet 55. First seen 13.4.46 with extensive firm oedema over left forehead, temple and upper eyelid which had developed gradually during previous month. X-ray examination showed that left frontal sinus was developed laterally to reach temple. Rubber tubes were inserted through floor of sinus medially and at its lateral extremity by an incision in the temple where a subperiosteal abscess was drained. The sinus was washed out through these tubes twice daily for three weeks. Then on 3.5.46 an attempt was made to explore the sinus by extending the temporal incision. Erosion of the anterior wall was found but access proved unsatisfactory.

On 7.6.46 a Killian operation was carried out with radical exenteration of the ethmoid labyrinth. The bridge of bone preserved in the operation has prevented serious deformity. A small quantity of pus continued to discharge by sinuses in the floor and temple for almost two years, but ceased spontaneously a month ago.

Case XXVIII. MR. I. B. THORBURN.

Miss E.B., aet 26. Admitted to hospital on 25.2.44 having been ill for eleven days with a left pansinusitis. There was gross oedema of left lower forehead and temple, marked proptosis and downward displacement of left eye. Shortly after admission she had a severe rigor.

Operation : Radical exenteration of left frontal sinus and ethmoid labyrinth. Mucosa of frontal sinus completely removed. It was partly necrotic and deeper layer calcified. Posterior wall of sinus was removed to a diameter of $1\frac{1}{2}$ inches to drain an extradural abscess. Wound packed and left open. Left intranasal antrostomy. Wound sutured a fortnight later.

Local abscesses have recurred four times, subsiding quickly with external drainage, but there has been no recurrence for the past seventeen months. There is marked depression deformity over the left frontal sinus with downward and outward strabismus. The vision of the eye is good but she has to wear a shield over it to prevent diplopia. Opinions sought regarding treatment of the strabismus and of the frontal sinus deformity.

Case XXIX. MR. A. FINLAY BROWN.

L.P., aet 59. Patient was first seen in July 1946, complaining of a soft swelling of scalp, increasing for past three weeks, and now involving the anterior half of the skull vault. Slight headache present but no other upset.

North of England Otolaryngological Society

Patient gives a history of trauma to the left fronto-parietal area. Twice he bumped his head on the windscreen of his car and once on the roof of a bus. Following these accidents a boggy swelling appeared but later subsided, and an X-ray at this time (*June 14th*) showed an area of rarefaction $1\frac{1}{2}$ inches long.

X-ray now shows marked extension of rarefied area with diffuse mottling of calvarium.

23.8.46. *Operation* : Exposure of skull through Coronal incision. Removal of area of bone 3 inches by 4 inches and release of extradural abscess. Severe bleeding from bony margin. Wound closed. Local penicillin introduced through drainage tubes in separate stab wounds. Penicillin I.M. 40,000 u. three-hourly. Three pints Group O blood.

30.8.46. Wound healed. Tubes and stitches out.

3.9.46. Discharged.

Two weeks later the wound broke down and from then on various collections of pus were released from the parietal regions. In *December 1946* further removal of diseased bone was undertaken and again in *January*. These operations resulted in the removal of the greater part of the vault of the skull.

The last removal of bone was done in *February 1947*, since when the patient has continued to attend for dressings, incisions and drainage round the scalp for evacuation of further collections of pus. These gradually became less and when seen in *November 1947* the whole scalp was well healed.

At present the patient is very well, has put on two stones in weight and is free from all headaches.

An appreciable amount of bony regeneration has taken place.

A series of X-ray photographs showing progress of the disease and extent of bony removal were shown.

A similar case which had survived for many years was quoted by the President.

Case XXX. MR. A. FINLAY BROWN.

L.J., aet 27 years. 14.4.47. Painless lobulated swelling over left upper jaw of three months duration. Tooth extractions eight weeks and three weeks ago. Hard mass present over left canine fossa. ? Dental cyst. Infiltration of left cheek (submucous) by firm, ill-defined rubber-like tissue. Similar condition of sublingual mucosa. X-ray left upper jaw. "Fractured roots in iv with inflammatory process on apices. Small bony sequestrum in alveolus of vi." Referred to Dental Surgeon.

28.4.47. Kahn test negative. Lavage left antrum negative.

30.4.47. Biopsy taken from cheek. Report : "The condition would appear to be of chronic inflammatory character. No evidence of malignancy." Patient was not seen again until 6.10.47.

6.10.47. Condition of mouth unchanged. Kahn and W.R. negative. Patient now discloses the appearance of a swelling about the size of a duck's egg in the left groin. It is painless, smooth and of rubber-like consistency. Patient referred to Surgical Department, where it was noticed that no other glandular swellings were present.

18.3.48. Removal of gland (Mr. Lennox) and biopsy. Report : "The microscopical appearances are those of lymphadenoma."

REVIEWS

MEDICAL RESEARCH COUNCIL SPECIAL REPORT SERIES, No. 261 HEARING AIDS AND AUDIOMETERS REPORT OF THE COMMITTEE ON ELECTRO-ACOUSTICS

THIS important Report was completed in April 1946. Its publication by H.M. Stationery Office was delayed until November 28th, 1947.

It goes, perhaps without saying, that the study of this report is not a task to be lightly undertaken. It deals with a wide range of complex and subtle problems and the results achieved, of considerable theoretical and practical importance, are concisely and expertly presented. The report represents the fruits of the labours of the team of eminent physicists and clinicians who comprise the Committee, and is a production of which English scientists may well be proud. It should certainly be on the desk of every otologist.

The main objective of the Committee was "To determine the characteristics of a hearing aid which will be of service to the majority of deaf people".

A broad outline of the work is given in the introduction. First a theoretical analysis of the problem was undertaken (Appendix II, p. 23). Figure 9 shows the solution which was obtained.

Next the theoretical solution was put to a practical test (Section 4). High quality speech reproducing systems were built incorporating facilities for introducing selective amplifications of various kinds. Special gramophone records were produced incorporating lists of monosyllabic words carefully chosen for graded intelligibility. Deaf patients then listened to the records and their scores were noted. The tests were repeated using different types of selective amplification and the corresponding scores of the patients indicated the relative values of the different types of amplifications.

These practical tests confirmed the theoretical solution.

As a result the Committee recommends (Section 5) that the overall acoustic amplification of any hearing aid for general use should approximate to the full curve in Fig. 1. The only tone control necessary is one capable of changing the high frequency amplification to approximate to the dotted line.

The next step was to construct a hearing aid having the desired characteristics (Appendix VI) and finally the models were tested against a representative series of commercial aids (Appendix VII). It should be noted that the criterion is "intelligibility". Every otologist will agree with the Committee's dictum,

The greatest loss suffered by deaf people arises from their inability to hear speech. Loss of other sounds, e.g., music and general noises is less important.

but it should be realized that the task of investigating a recondite property like "intelligibility" and above all of correlating it with measurable characteristics such as intensity amplification and frequency range presents very great difficulties.

The tests presented many problems both technical and psychological.

Reviews

Similar subjective tests are used by telephone engineers because the transmission of intelligence by speech, involving mental reactions which are not directly measurable, can be assessed in no other way. The Committee encountered extra difficulties from the fact that the tests had to be performed on deaf persons who had had no previous experience of the work (page 6).

The intelligibility amplification of a given hearing aid is easily understood as an idea, but it is extremely difficult to investigate accurately. It may be high for one patient and low for another. Even with a given patient it may be high for male voices and low for female voices. It is thus more than satisfactory that as a result of this work the production of a standard hearing aid has been finally justified.

The reader who approaches this report for the first time should start with the preface and introductory remarks and then go on to Sections 1, 2 and 3. These give a broad outline of the work as a whole. He should then study the experiments in Section 4 and then go on to Section 8. He will then be ready to appreciate Appendix VII which, from the viewpoint of the otologist is the most interesting and important part of the report. Sections 5, 6 and 7 and Appendix I deal with practical specifications and should be reserved for a later study. Appendices IV and V deal with the technique for assessing the performance of hearing aids. They are well worth reading. A modest knowledge of electro-acoustic phraseology is required. Appendix II is much more technical and is of more interest to the engineer.

Appendix VII merits special attention. It deals with the clinical testing of hearing aids, i.e., the determination of speech audiograms. It starts, as all scientific investigations should, with a discussion of the general principles underlying the design of the test procedure. The aim is to test the sentence intelligibility, but for practical reasons words and not sentences were used. A first step therefore was to correlate word articulation with sentence intelligibility. It was found that 40 per cent. word articulation corresponded to 90 per cent. intelligibility; in other words, if a patient can recognize 40 per cent. of the test words at a given intensity he will be able to understand 90 per cent. of all speech at that intensity. The figure 40 per cent. was found to be critical, that is to say quite a small drop in word articulation resulted in a severe loss of intelligibility. The test resolved itself, therefore, into determining how loudly the records had to be played, to give a 40 per cent. score. In practice the records were played at three different standardized intensities based upon certain of the Beasley gradings of social disability.

Grade 1. The intensity of speech as heard in Church or Theatre.

Grade 2. The intensity of speech heard in quiet conversation at 3 feet.

Grade 3. The intensity of speech as heard in loud conversation at 3 feet, or over the telephone.

A line drawn through these three points constitutes a speech audiogram. It shows how much benefit a given patient can derive from a given hearing aid. If the tests are repeated on a series of aids, the most suitable one for that patient can be determined.

Certain differences between speech audiometry and pure tone audiometry should be borne in mind.

Pure tone audiometry deals with the function of the ear at or near threshold.

Reviews

The hearing for speech generally concerns the function of the ear at intensities well above threshold. As is well known to the otologist, the disturbances of these two functions do not always go hand in hand. In the practical matter of testing the hearing for speech, speech tests at levels well above threshold carried out in the manner suggested by the Committee have obvious advantages.

The otologists will naturally enquire whether these intelligibility tests have any direct application in his clinical work. It has been suggested that they should be incorporated in the routine examinations of a hearing aid clinic. That is manifestly unnecessary and the Committee certainly does not suggest it. The routine work of a clinic will consist of providing one or other of the two available instruments. Elaborate and time-consuming intelligibility tests will be quite unnecessary. On the other hand, it seems most likely that this technique will have a wide application in the investigation of the limited number of patients for whom a standard aid is ineffective. It seems possible also that it will find a useful application in the assessment of deafness for medico-legal and pensions cases. The research student will also welcome this instrument as a powerful means of investigating the auditory function at supra-liminal intensities.

The section on audiometers is on the whole disappointing. It adds little to what is already known and its recommendations are somewhat vague and unambitious. It is regretted in particular that so little is contributed to the practical problems of hearing, by bone conduction and masking devices, which play so important a part in the routine of practical otology.

Appendix IX gives a resume of an examination of the characteristics of a number of commercial audiometers. Accuracy of frequency scale and of attenuator steps—upper and lower limits of intensity—purity of wave form and the level of the mains hum were all investigated. In addition, the response frequency characteristics of various audiometer receivers were determined on an artificial ear. These are shown graphically in Fig. 27, and will repay careful study. The peaks and valleys are most striking and explain the importance of exact frequency calibration. The Committee draws attention to the desirability of a flat response characteristic, but has refrained from laying down any limits, merely insisting that the tolerance on frequency shall be 3 per cent.

Measurements of the threshold of audibility were carried out upon a small team of 11 subjects. The average threshold readings obtained by this group varied with the different instruments. Thus, the average threshold readings obtained at a particular frequency with one audiometer indicated a hearing loss of 21 db. With a second audiometer the corresponding readings indicated a hearing gain of 1 db., and the Committee point out the likelihood that still greater discrepancies would be found in audiometers in general use. Concerning the reproducibility of threshold readings obtainable with any given instrument, this varied with frequency. The smallest standard deviation found was 3-4 db., but this figure was exceeded at higher frequencies.

This was attributed to the important part played at these frequencies by certain physical factors, in particular the closeness of fit of the receiver to the ear.

For receiver calibration the Committee recommend a combination of subjective tests with purely physical measurements upon an artificial ear. The following is the procedure prescribed (page 62):

Reviews

For any one type of air-conduction receiver, a representative "standard" should be selected after objective examination of the performance of at least three receivers of the type. This "standard" should be calibrated subjectively in a room free from external noise, in terms of the electrical input required to produce the average normal threshold, by measurements on a group of subjects sufficiently numerous for the mean and mean deviation to be significant. The subjects employed should be within the age limits of 18-25 years and should have no symptoms or signs of ear disease as determined by an otologist. Their ears should be examined to ensure that the external auditory canal is free from wax.

In determining the threshold, the intensity of the tone should be reduced in steps of 5 db. from an easily audible level until it becomes inaudible. The intensity should then be increased in similar steps from a level well below the threshold until the tone becomes audible. The threshold value should be taken as the mean of the lowest levels at which the tone is heard. Care should be taken to avoid fatiguing the subject.

Receivers which are duplicates of the subjectively-calibrated "standard" may be calibrated by objective comparison with the "standard" on an artificial ear.

Calibration of the bone oscillator follows the same plan. A "standard" chosen out of any given batch is calibrated subjectively. All others are calibrated by objective comparisons with the standard on a suitable form of vibration measuring instrument. No reference is made to the problem of relating B.C. loss to A.C. loss.

A visual signal is recommended for the patient's use. A microphone circuit is recommended for communication between listener and operator. In the writer's experience this is rarely necessary, but it is certainly desirable to have such a circuit so that gramophone records can be played over for standardized speech tests. The importance of maintaining calibration is emphasized and periodic checks by a standardizing laboratory are recommended.

The ability of an audiometer to exhibit the correct relationship between the hearing losses of different subjects depends on the accuracy of its attenuator (page 65).

The following tolerances are laid down :

a. The nominal 5 db. steps shall be not less than 4 db. and not greater than 6 db.

b. The difference (in decibels) of the actual levels of a tone at any two settings of the attenuator scale shall be within 5 db. of the difference between the scale readings.

c. The overall performance shall be such that the actual intensity level of any tone at any setting referred to the accepted standard subjective zero determined by the method of calibration described in the specification shall be within 5 db. of the indicated value (page 71).

In addition, the Committee lays down a suitable intensity range in Table V. An upper limit of about 100 db. is recommended and a lower limit of *at least* 15 db. below normal threshold.

An interesting investigation revealed that all receivers gave rise to vibrations of the whole skull, which could be measured by a vibration pick-up on the

Reviews

opposite mastoid. A distinction was drawn between true "Structure born" vibration, i.e., vibration communicated mechanically from the receiver by direct contact with the head, and "air-borne" vibration set up by the sound waves in the air under the receiver. A series of ingenious experiments proved the latter to be much more important.

Clinicians will perhaps not be very interested in the precise details of the artificial ears described in Appendix III. Nevertheless, the section is well worth reading if only because of the instruction it provides upon certain principles of acoustic measurements.

In order to ascertain properly the characteristics of a telephone receiver it must be made to work into an acoustical load having approximately the same acoustical impedance as the average human ear, otherwise the response of the receiver will differ from that which it will give in actual use (page 37).

Appendices IV and V deal with the measurement of the performance of hearing aids. Here again the necessity for "measuring" under correct conditions is stressed. Artificial ears are utilized and corrections are made for the obstructing effect of the human head, or for the hearing aid microphone as the case may be.

It is necessary to stress the fact that while these tests give a measure of the comparative performance of hearing aids under reproducible conditions approximating as closely as is practicable to the conditions of actual use, the amplification so measured may differ somewhat from that experienced subjectively. It has been found that with a badly fitting receiver, or with one held by a loosely fitting headband, appreciable leakage of sound may take place leading to a poorer response than that indicated by a test with an artificial ear, particularly at the lower frequencies. Allowance must be made for this in the design of a hearing aid (page 42).

It should be added that this *objective* testing of hearing aids is necessary for the practical specifications of instruments in connection with design, reproduction and so on. It is supplementary to, and cannot replace, the subjective methods described in Appendix VII. The ultimate criterion is the degree of benefit which an aid affords to a deaf person. Direct subjective tests are, of course, too cumbersome and indeed unnecessary for routine clinical examinations, nevertheless objective tests only have validity because as shown in Appendix II they can be correlated with the articulation efficiency of the instrument as determined subjectively.

As already indicated, clinicians are likely to find the report disappointing in that it includes no reference to the subject of bone conduction tests, nor to the technique of masking. These tests are vital in diagnosis, and yet their meaning is often wrapped in obscurity. There is urgent need for fundamental research, such as can only be undertaken by a Committee of this calibre commanding the full resources of our greatest laboratories. It is, therefore, a matter of urgent concern that this work, which has been so well begun shall be continued, and all will hope that when completed its results will appear in the form of a successor to the present report. Such a publication will be welcomed by otologists everywhere and indeed by all who are interested in the problems of deafness.

A. TUMARKIN.

SPEECH AND VOICE CORRECTION

THIS is a book edited by Emil Froeschels, M.D., President of the International Society for Logopedics and Phoniatrics and President of the New York Society for Speech and Voice Therapy. There are 19 contributors, most of them attached to institutions for treatment of the voice, speech and hearing. There are 22 chapters in all. The first, on anatomy and physiology, is excellent and should be a great help to those who propose to practise Speech Therapy, as well as to those already doing so. References are made to various types of breathing, costal, epigastric and abdominal. On breathing for voice, there is on page 7 this statement : " In testing eight prominent singers we could establish the fact that each of them breathed differently. From this we concluded that singing teachers should not recommend any general type of breathing." The eight prominent singers probably never learned not needed to learn about breathing. These were well equipped with excellent lung capacity and would have perfect elasticity of the throat and chest muscles. These are the born singers and in England these are not many in number. There are many potentially really good singers and they need careful training in the development of their lungs. The chest should be developed definitely in the lower costal region. This development will ensure the perfect descent and extension of the diaphragm and bring about whole lung breathing. The abdominal muscles must be trained to contract powerfully and drive up the great viscera and so press up the diaphragm. The abdominal muscles in contraction become the motive power of the voice. During inspiration the abdominal wall must remain perfectly still. This will stop the pernicious belly-breathing which causes much ill-health from visceroptosis. A good deal is set out in this same chapter on the consonants and vowels and on the zones of articulation which deserve careful study by the student.

In Chapter 2, aphasia is ably dealt with by another contributor. It is a wide subject and the writer rightly says that speech therapy for aphasic children and adults must be planned to satisfy the special biological, social and economic needs of each patient. He is rather unhopeful of rapid progress in the aphasic adult, and says he must expect to expend years, not months, to regain a part of his reading, speaking and writing ability. In severe cases this is true but milder cases may improve in a few weeks. Chapters on dysarthria and alalia are worthy of careful study. The types of case described are not common in the hospital speech clinic in England. Dyslalia includes all functional defects of articulation and its various types are set out and named, and such names are recognized by the Committee of the American Speech Correction Association. They are new, in some instances, to Speech Therapists in England. The treatment for many types of dyslalia is carefully described and should be very helpful.

Rhinolalia is dealt with in another chapter. The writer sets out various exercises for overcoming this distressing affection. A very effective method of overcoming the impaired movement of the soft palate which is often causing the rhinolalia is the use of a tongue depressor night and morning, depressing the back of the tongue on the sound of " Ah ". This is not set out in this chapter but it is worth trying when there is a paresis of the palate. As the back

Reviews

of the tongue is pressed down on the sound of "Ah" the soft palate is drawn up, and if the voice is kept low in pitch complete recovery should occur.

The chapter on hearing rehabilitation is naturally very technical and is possibly outside the field of the ordinary Speech Therapist.

The chapter on cleft palate operations leaves out one famous English surgeon's name. Sir James Berry followed Langenbeck's method and his results were very good indeed. Sir Arbuthnot Lane spared many mothers the shock of seeing their children badly disfigured by hare-lip by doing a very early operation to remedy matters. Lane employed a flap operation to close this palatal cleft which did give some very good speech results. Brophy's operation was very severe, the hard palate being closed by traction wires through the superior maxilla and lead plates. The discomfort to the patient must have been rather great. We understand that now most successful plastic operations are performed which give wonderful results in the functioning of the reformed palate and in the speech.

The chapter on stuttering sets out the various ideas of several individuals. No difference between stammering and stuttering is made. The names of seven authorities are set out as believing that stuttering is induced by making a left-handed person use the right hand. In reality, stuttering or stammering being of emotional origin, the annoyance caused to the patient by being made to use his right hand instead of the left may aggravate a stammer. It is difficult to see how it could cause it. Stammering or stuttering generally comes on in the third or fourth year of a child's life. It comes on gradually and affects those who are born with a highly developed and sensitive speech centre which, on strong emotions of the mind, gets over stimulated, and the speech centre like any other centre is disordered or is upset by hyperæmia. This is the opinion of the reviewer, but Henry Munro in a tract, in the Library of the Royal College of Surgeons, written in 1850 makes this perfectly clear. His own words are as follows :

"There exists in some individuals an idiosyncrasy amounting probably only to a great irritability or sensibility of fibre in that part of the brain or ganglia as well as their efferent nerves which control the motions requisite for speech and this peculiarity exposes it to be most easily deranged and driven into spasmodic action by the mental desire to speak. If there exists a tendency to local congestion about any of the motor fibres of the brain or spinal ganglia it would itself cause irritable spasmodic action or paralysis (in proportion to the amount of pressure) of the muscles supplied by them."

Young children treated by lower costal development and using a contraction of the abdominal muscles as they speak may be cured of a stammer in a few weeks' time. There are 87 references set out at the end of this chapter on the subject of stammering and stuttering, so there is a wide field of selection for the student anxious to learn a variety of opinions. Munro seems to have found out the true cause of stammering and stuttering. It is convenient to differentiate between stammering and stuttering in this way. Stammering relates to difficulty of production of the voiced consonants and words introduced by vowels and stuttering to the rapid repetition of the breathed consonants.

The chapter on cluttering is excellent and the treatment set out most helpful. This form of speech trouble is rare and when first seen may puzzle

Reviews

the Speech Therapist. There is a very interesting chapter on disorders of speech due to gunshot wounds. The chapter is thorough in detail and helpful in assisting the return of normal speech to patients suffering from serious head injuries.

The description of the methods of educating the speaking voice and education and re-education of the singing voice is interesting. Re-education will interest the Speech Therapist more than the education of the person who wishes to have his or her voice trained. The normal voice does not appeal to the Speech Therapist as do voices which have become affected and are in serious trouble. Of course, all such conditions are diagnosed by the Throat Specialist or by some Medical Practitioner before the Speech Therapist is asked to deal with them. The reference to singers not knowing whether their voices should be high or low in pitch needs amplification. The test is quite simple. If on the sound of "Ah" a deep note can be produced the voice in a man is bass or bass baritone, and in a woman contralto or mezzo soprano. The true tenor and soprano cannot produce deep notes. A great waste of time and money would be avoided if the young singer were told by an expert what kind of voice he or she should be trained for.

The last chapter is on the esophageal voice. The writer of this chapter advises that the patient who is to undergo laryngectomy should be fully instructed as to the operation and should learn from charts or sketches what the throat will be like when the larynx has been removed. All this might fill the patient with apprehension, but the advice that the patient should see and hear another person who has had the operation and can speak well is very wise and will give the patient hope and confidence. Some laryngectomy patients with excellent voices are always ready to demonstrate their success in talking and in showing how well in health they are. If this practice were universal much good would result, but unfortunately it is not and many patients have no idea that they may speak again. The high percentage of them do so. The earlier instruction on how to get a voice is given the better. Colledge likes his patients to attempt to get a voice very soon after the extirpation of the larynx, in fact as soon as any leakage from the pharynx has ceased, even if healing is not complete. The line of treatment set out in this last chapter is fully explained and should be helpful. The time for getting a voice varies a lot with patients. In England voice has often been acquired at the first treatment. A man seen once only for vocal education returned after four years with a voice practically normal. Another patient, a clergyman, operated upon in 1930 is still well and can take a whole service through, including the sermon. Two others have been Masters of their Masonic Lodges, and made long speeches which were easily heard by all present at meetings. Another, a solicitor, speaks so well that his clients do not know he has lost his larynx.* The patients speak on a belch which is very evident at first. Later on this is refined and the voice becomes very good. A help to acquiring voice is to drink some effervescent liquid. In conclusion, every effort should be made to teach the patient to get an esophageal voice before he starts trying to talk in a whisper. An artificial larynx should only be used when it is clear that the patient will never be able to produce a voice. Such cases are few.

CORTLANDT MACMAHON.

*All these cases were operated upon by Colledge and were trained by the reviewer.

ABSTRACTS

EAR

Some remarks on the Fenestration Operation and what leads to the results.

J. VENKER. *N.V. Noord-Hollandsche Uitgevers Maatschappij.*
Amsterdam, 1947.

This monograph is based on the author's experience of the fenestration operation on 25 patients.

After a comprehensive outline of the development of the surgery of otosclerosis an account is given of the author's equipment and procedure that includes a description of a one-piece suction and flushing device for clearing the operative field.

Short notes of twelve operated cases are given and there is a general review of post-operative complications, results, and indications for operation.

Slight improvement in hearing in the non-operated ear has been noted in some cases and is attributed to an active vasomotor reflex, thus re-affirming Gray's theory.

Further support for this theory is offered by a number of cases of otosclerosis in which the deafness remained stationary for some years and which all exhibited a good vascular reflex of the tympanic membrane. Also the vasodilatation that followed the inhalation of amyl-nitrite was sometimes accompanied by an improvement in the hearing. Mention is also made of operations upon the aural sympathetic ganglia and peri-arterial sympathectomy of the carotid artery in cases of otosclerosis.

This 73-page monograph is illustrated by one plate and 53 charts and diagrams and it has 118 references.

T. E. CAWTHORNE.

Surgery of the Seventh Nerve. THOMAS D. TICKLE, M.D. (New York). *Jour. A.M.A.*, April 10th, 1948, cxxxvi, 15, 969.

The writer reviews the literature on this subject, especially the work of Ballance and Duel.

A patient with paralysis of the facial nerve in which response to faradic stimulation has been lost and the angle of whose mouth in repose is drooping should have surgical treatment.

Some sort of magnifying glass is essential.

Cases in which paralysis appears immediately following a simple or radical mastoidectomy and in which faradic stimulation is lost within 72 hours should have the nerve uncovered and inspected.

Surgical damage to the nerve occurs when the operator has gone too low when trying to locate the antrum, when curetting the retrofacial cells, when probing the antrum too vigorously or when curetting granulations from the floor.

Ear

Pre-operative paralysis in acute otitis media is of itself no indication for operation but if there is a quick loss of faradic response and evidence of mastoid involvement a simple mastoidectomy without decompression should be performed.

Pre-operative paralysis in chronic cases is quite different and radical mastoidectomy without decompression is indicated. If there is a faradic response and no fistula seen, decompression may be postponed for six weeks.

When a decompression is done, the nerve should be uncovered from the stylomastoid foramen up to the geniculate ganglion and the sheath slit over the entire exposed nerve.

When small strands of nerve are left these strands should be preserved.

When the nerve is divided, the writer prefers the nerve graft although he has had satisfactory results from the so-called cable graft.

In re-routing the nerve, it is almost impossible to get a dry ear.

Sutures in grafts and end to end anastomosis operations are not advisable.

An infected wound is not a contra-indication to doing a nerve graft.

When there is no response to galvanic stimulation, showing the muscles have either atrophied or have become fibrosed, operation is useless.

In the 10 per cent. of cases of Bell's Palsy which do not recover spontaneously and which lose response to faradic stimulation and show no improvement in six weeks time, a decompression operation should be done.

The function of the frontalis muscle practically never recovers and the patient will rarely be able to elevate the upper lip on the paralysed side as well as on the good side.

The article has a bibliography.

ANGUS A. CAMPBELL.

Chorda Tympani Nerve Graft: A Preliminary Report of a New Technic used in Surgical Fenestration of the Labyrinth. SAMUEL ROSEN, M.D. (New York). *Archives of Otolaryngology*, 1948, xlvi, 4, 428-437.

The chorda tympani nerve is liberated from its attachment to the facial nerve and is placed over the fenestra to protect the membranous labyrinth and the perilymphatic space from the untoward effects of blood and inflammatory products coming mostly from the overlying tympanomeatal flap.

A series of eight consecutive patients operated on with the new technic showed recovery of useful hearing within two weeks and continued improvement during the first seven months.

Data are presented from four other series of cases showing the results of early post-operative audiometric testing and the four series and the present series are compared with respect to the six week and one year audiometric results.

R. B. LUMSDEN.

Calcium and Phosphorus, and Phosphatase Activity in Otosclerosis. EDMUND PRINCE FOWLER, M.D. (New York). *Archives of Otolaryngology*, 1948, xlvi, 4, 491-500.

The blood serum calcium, phosphorus and phosphatase determinations in 160 patients indicate that phosphorus (inorganic phosphate) was below 3.5 mg.

Abstracts

per hundred cubic centimetres (the low limit) in 62 per cent. of the women and 56 per cent. of the men. The calcium also was definitely on the low side, being below 9.5 mg. per hundred cubic centimetres in 70 per cent. (66 per cent. of the women and 80 per cent. of the men). The phosphorus was below 3.5 mg. in two-thirds of those with calcium below 9.5 mg. and the calcium was below 9.5 mg. in over two thirds of those with phosphorus below 3.5 mg. The percentage of patients in which association of low calcium and low phosphorus occurred has not heretofore been demonstrated in studies of otosclerosis.

The phosphatase activity was within normal limits except in a few of those with low calcium. The possible significance of such findings is discussed.

It would appear that the important implication of these blood chemistry determinations is that intake and utilization of calcium and phosphorus should be carefully studied and controlled, especially during those periods of life when an ample supply is necessary for the good health of the body as a whole, and particularly in those cases in which there is a family history of otosclerosis, with a view to insuring the maximum required for health of the bone containing the inner ear. In view of the findings it would be folly to neglect this in spite of the meagreness of knowledge of the causes of the lesions of otosclerosis or of the causes of their activity.

R. B. LUMSDEN.

NOSE

Tumours of the Nose and Sinuses. LEROY A. SCHALL, M.D. (Boston). *Jour. A.M.A.*, August 7th, 1948, cxxxvii, 15, 1273.

This article is based on a study of 219 patients seen during the past 16 years.

Hæmorrhage, nasal obstruction, referred pain, painless swelling, sensory changes in the cheek and exophthalmos should cause the rhinologist to suspect cancer in this area.

A biopsy should be done in every case and an exploratory operation may be advisable so that the plan of treatment can be outlined. A quick section is not recommended.

Repeated roentgen examinations in suspicious cases should be the rule.

If the biopsy shows the tumour to be an anaplastic new growth, radiation may be used alone. When the new growth is not of the anaplastic type, surgical treatment followed by radiation or the direct implantation of radium, in the operative field supplemented by external radiation, is the treatment of choice.

Adequate exposure may be obtained through a lateral rhinotomy using a modified Moure incision. Free bleeding may be encountered but it has not been found necessary to ligate the carotid artery. The entire operative area should be desiccated with a coagulating current and radium inserted to destroy any scattered tumour cells. Depending on the sensitivity of the tumour, radium is left in place for a total of 2,000 to 4,000 milligram hours.

If exophthalmos exists, the orbit is exenterated.

The writer feels that patients treated primarily by surgery supplemented by external radiation or by means of radium in the operative cavity have a better than 2 to 1 chance of a 5 year survival than those treated primarily by radiation.

Seven detailed case histories are given.

ANGUS A. CAMPBELL.

Nose

Disturbances of Olfaction resulting from Intranasal use of Tyrothricin: a Clinical Report of seven cases. ERNEST M. SEYDELL, M.D. and WILLIAM P. MCKNIGHT, M.D. (Wichita, Kan.). *Archives of Otolaryngology*, 1948, xlvii, 4, 465-470.

Eight cases are reported in which anosmia or parosmia developed immediately, or shortly after, a solution of tyrothricin began to be used in the nose. These symptoms have been persistent, ranging in duration from four to eight months. The symptoms have outlasted by months the condition for which the solutions were originally prescribed. None of the patients were suffering from clinical influenza at the time of use of the solutions.

One patient was tested by injecting camphor water U.S.P. intravenously and showed no response. This would definitely place her condition in the category of an essential anosmia.

R. B. LUMSDEN.

Nonregeneration of the Mucous Membrane of the Frontal Sinus after its surgical removal (in the dog). GEORGE E. LIEBERMAN, M.D.(Phil.), and J. W. BABB, M.D. (London, Canada). *Archives of Otolaryngology*, 1948, xlvii, 4, 421-427.

Ten dogs were operated on over a period of one year, removing the mucous membrane from the frontal sinus, and opening the sinus two weeks, one month, two months, three months and four months later to observe the results. Four of the dogs died of intercurrent infections; the remaining six stood the operative procedures well and were in good condition at the end of the year.

Sections of the normal mucosa were removed at the first operations, as a control.

The lack of regeneration of mucous membrane in the surgically treated frontal sinuses of dogs was striking. No inflammatory exudate was seen in any specimen. What was present was a fibrous tissue process, with new bone and cartilage probably coming from the periosteum.

This work may explain some of the poor results which have so often followed radical or extensive operations on the paranasal sinuses in the human being.

R. B. LUMSDEN.

On the control of the Diphtheria Bacillus in the Chronically Diseased Nose. W. MESSERKLINGER (Graz). *Monatsschrift für Ohrenheilkunde*, 1948, lxxxii, 303.

In a series of 30 patients suffering from chronic nasal disease, the presence of diphtheria and diphtheroid bacilli was established in every case. Of these, 11 colonies in pure culture were obtained and re-examined, resulting in the establishment of 9 definitely positive but weak or avirulent colonies. Two had the attributes of the Gravis and Intermedius strains, one of the Intermedius, and six of the Mitis.

The avirulence, and the relatively frequent occurrence of the Intermedius strain is regarded, according to the opinion of several writers, as a peculiarity of the diphtheria organism. The secretion from the diseased nasal mucosa has a minimal antibacterial effect, resulting in a gradual transition to the diphtheroid form.

Abstracts

Of the colonies examined, 87.5 per cent. came from cases of atrophic nasal disease. The difference is stressed between diphtheria carriers with otherwise healthy nasal passages, and those with chronic nasal infections. The former, in the course of weeks or months, and with increasing resistance of the mucosa, tend to lose their diphtheria bacilli. The latter, on account of the irreversibility of the disease process in their noses, keep the organisms for the duration of the nasal disease—that is for the remainder of their lives.

Although, according to our present knowledge, the bacilli in the nose are practically harmless, they are extremely resistant to treatment, which is, on the whole futile.

D. BROWN KELLY.

MISCELLANEOUS

Treatment of Migraine with Histamine. DOROTHY MACY, Jr., M.D. and BAYARD T. HORTON, M.D. (Rochester, Minn.). *Jour. A.M.A.*, July 24th, 1948, cxxxvii, 13, 1110.

The following five factors are fundamental to the migraine syndrome: periodicity, cephalalgia, gastro-intestinal dysfunction, cortical disturbance and family history.

The pain is vascular in origin and is due to vasodilatation.

Morphine and all habit forming drugs have no place in its treatment.

One hundred and forty four migrainous patients were treated with histamine alone. In one-third of the patients, the syndrome was unchanged by treatment. Over one-half of the patients showed significant improvement and subcutaneous administration was found to be more effective than the intravenous methods. The administration of the drug by both subcutaneous and intravenous routes was found to be the most effective. There appeared to be no constant relationship between the total dose of histamine and the degree or duration of the abatement of symptoms.

Histamine was not found to be either a specific or truly curative agent in the treatment of this syndrome but until such an agent appears, histamine will continue to have an important place.

ANGUS A. CAMPBELL.

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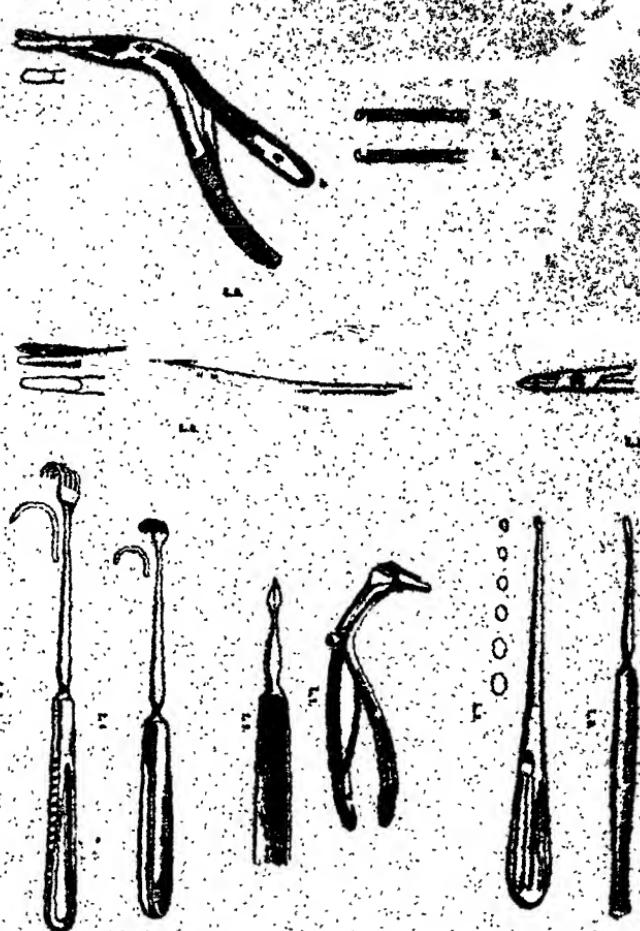
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Contents

- LEMPERT FENESTRA NOV-OVALIS FOR THE RESTORATION OF PRACTICAL UNAIDED HEARING IN CLINICAL OTOSCLEROSIS: ITS PRESENT STATUS JULIUS LEMPERT
- MUCOCLE OF THE FRONTAL SINUS EDWARD F. STEWART
- STAPHYLOMYX (SEYFELD'S TENDOMY) L. R. S. TAYLOR AND G. H. BATEMAN
- CLINICAL RECORD—
- A CASE OF LIPOIDOSIS SIMULATING DOUBLE MASTOIDITIS A. S. HANDOUSA BEY
- CLINICAL NOTE—
- "SPURGE" ULCERATION OF THE EXTERNAL AUDITORY MEATUS W. M. MOLLISON
- SOCIETIES' PROCEEDINGS—
- ROYAL SOCIETY OF MEDICINE—SECTION OF OTOLARYNGOLOGY MADIGAN ARMY HOSPITAL
- ROYAL SOCIETY OF MEDICINE—SECTION OF OTOLARYNGOLOGY WITH FEDERAL DEPT OF PHYSIOLOGY PROPERTY OF U.S. ARMY
- GENERAL NOTES

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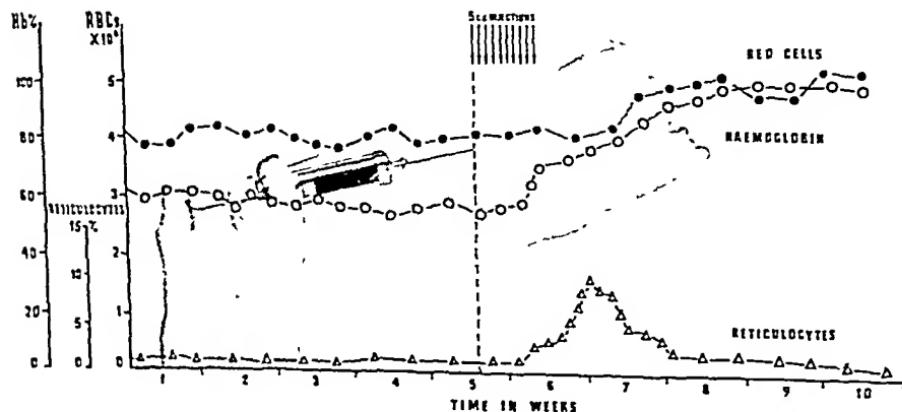
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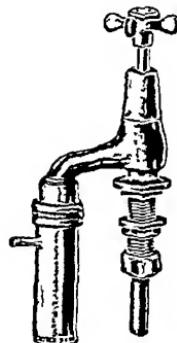
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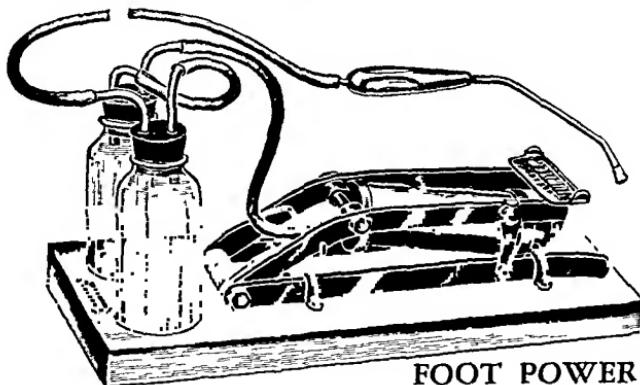


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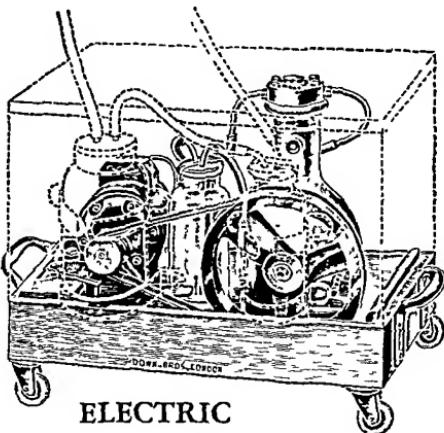
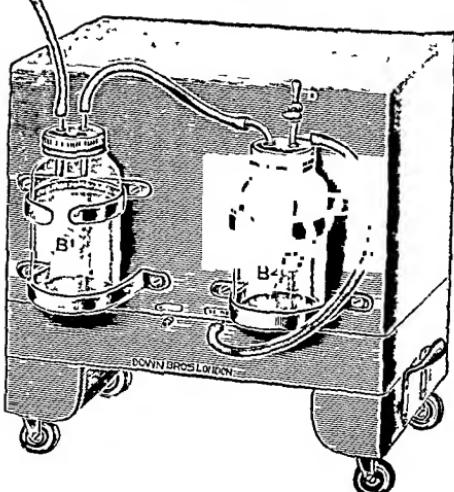


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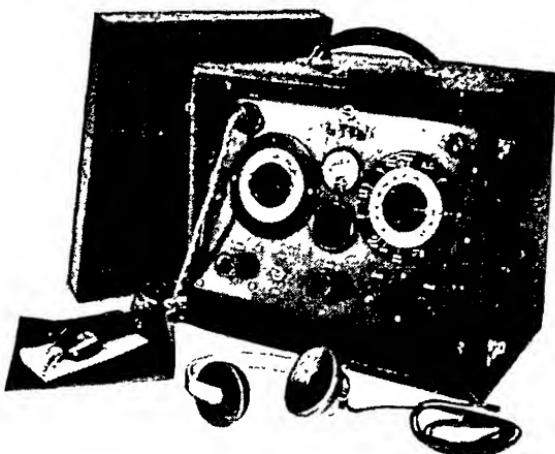
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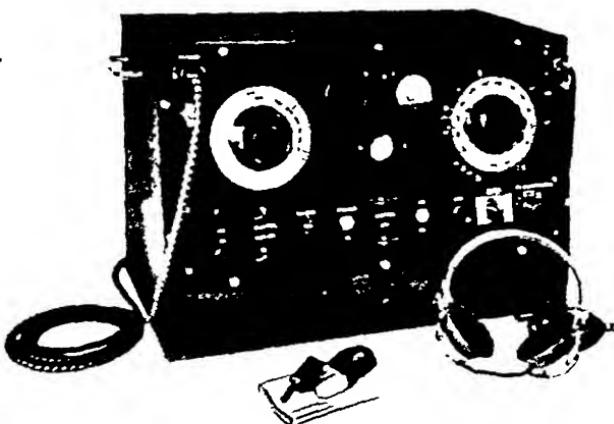
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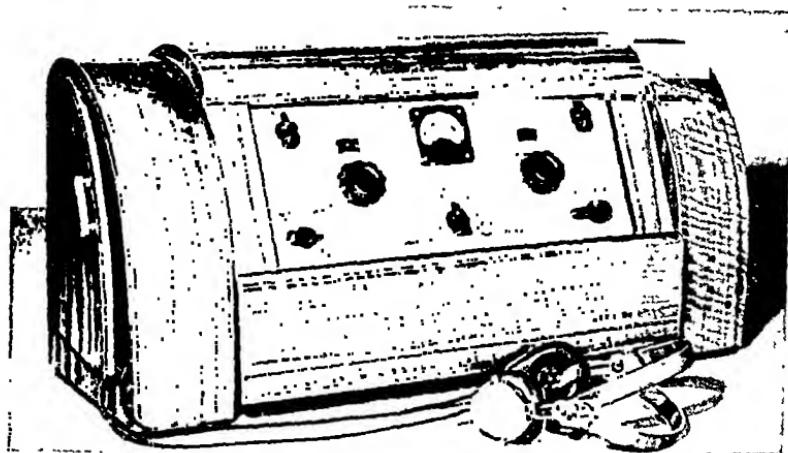
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CONTENTS

	PAGE
LEMPERT FENESTRA NOV-OVALIS FOR THE RESTORATION OF PRACTICAL UNAIDED HEARING IN CLINICAL OTOSCLEROSIS: ITS PRESENT STATUS. Julius Lempert (New York, U.S.A.)	57
MUCOCELE OF THE FRONTAL SINUS. Edward F. Stewart (London)	70
STAPEDIOTOMY (STAPEDIUS TENOTOMY). L. R. S. Taylor and G. H. Bateman (London)	79
CLINICAL RECORD—	
A Case of Lipoidosis simulating Double Mastoiditis. A. S. Handousa Bey (Cairo, Egypt)	81
CLINICAL NOTE—	
"Simple" Ulceration of the External Auditory Meatus. W. M. Mollison (London)	85
SOCIETIES' PROCEEDINGS—	
Royal Society of Medicine—Section of Otology	87
Royal Society of Medicine—Section of Otology with Section of Laryngology	91
GENERAL NOTES	106

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February 1949

LEMPERT FENESTRA NOV-OVALIS FOR THE RESTORATION OF PRACTICAL UNAIDED HEARING IN CLINICAL OTOSCLEROSIS : ITS PRESENT STATUS*

By JULIUS LEMPERT (New York, U.S.A.)

WHEN I first became interested in the surgical treatment of clinical otosclerosis I decided to direct my efforts towards developing and perfecting this surgery to a degree high enough to render its use by the otologist practical and its benefits to the deafened patient desirable and durable. It soon became obvious to me that to reach this objective I would have to :

1. Create a technically safe and practical one-stage surgical procedure for the restoration of practical hearing in clinical otosclerosis.
2. Find means for ascertaining preoperatively the likelihood of obtaining practical, serviceable and unaided hearing in a deafened ear following the use of such a technique.
3. Find definitely prescribed ways and means of assuring the permanency of the practical hearing improvement once obtained following such surgical intervention.

In *Archives of Otolaryngology* (1938, xxviii, 42-97) I described the first practical one-stage fenestration technique for the improvement of hearing in clinical otosclerosis. During the last ten years I have developed many technical improvements in the surgery for clinical otosclerosis. These were based upon a continuous study and analysis of the various

* The Paper was followed by the projection of a colour film illustrating every detail of the operation.

Julius Lempert

results obtained following 3,700 fenestration operations which I have performed, the observations I have made during the performance of 450 revisions and the histologic findings of scientifically controlled animal research.

The restoration of practical hearing following fenestration surgery was observed to be influenced by factors of preoperative, operative and postoperative origin.

Preoperative Factors Influencing the Restoration of Practical Hearing

The preoperative diagnosis of clinical otosclerosis is not difficult. In performing the *fenestra nov-ovalis* operation stapedial foot-plate ankylosis has been observed in almost 100 per cent. of cases diagnosed as clinical otosclerosis.

In the only two cases that later came to autopsy of irrelevant causes the otosclerotic lesion was histologically present.

The fenestration operation serves those deafened as a result of otosclerosis best, when their preoperative cochlear nerve function reservoir has remained adequate enough to permit the restoration of practical serviceable unaided hearing.

If the restoration of practical hearing in clinical otosclerosis is to be the objective of the fenestration operation it is essential that the preoperative bone conduction hearing for the 512, 1,024 and 2,048 pure tone frequencies should not be lower than the 30 decibel level and that the decibel level of the bone conduction hearing should be at least 25 to 30 decibels higher than the decibel level of the air-conduction hearing.

Experience has shown that an improvement in hearing for air-conducted sound following fenestration must reach at least the 30 decibel level in the 512, 1,024 and 2,048 frequencies to be considered as serviceable enough for social and economic purposes and obviating the necessity of wearing a hearing aid.

Hearing can be restored to the practical level or higher, even as high as the normal level by the fenestration operation, providing the reservoir of unused cochlear nerve function still present at the time of operation is sufficient to permit such restoration of hearing. In the presence of an adequate cochlear nerve function reservoir the degree of the preoperative hearing loss for airborne sound, no matter how great, will nevertheless not interfere with the restoration of practical hearing.

The correct determination preoperatively of the cochlear nerve function reservoir remaining untapped by the functionally impaired air-conduction mechanism is not difficult if the otologist possesses a good old-fashioned clinical sense plus an appreciation of the psychology of the deafened. By supplementing the audiometric testing with

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intelligent use of the old-fashioned 512, 1,024 and 2,048 frequency steel tuning forks for testing bone conduction hearing for pure tone, plus the use of the outmoded speaking tube for testing the intelligibility for the spoken voice, the otologist can obtain much more valuable information as to the possibility of restoring practical hearing with the fenestration operation in a given ear than by accepting the reports of conclusions reached by physicists and acoustic engineers with the use of extremely complicated apparatus in their psycho-acoustic laboratories.

No otologist should perform a fenestration operation without first personally testing the patient to determine his chances for the restoration of practical hearing. He must never operate solely on the findings of another otologist.

Though the need for newly developed accurate tests for differentiating between middle- and inner-ear deafness is greater today than ever before, only the development of simple non-complicated tests practical enough for the average otologist to employ in his office will be acceptable in the long run.

If, following a well-performed fenestration operation, an impressive hearing improvement cannot be audiometrically demonstrated despite the presence of a strongly positive response to the fistula test it may be concluded that the cochlear nerve function reservoir was incorrectly evaluated preoperatively. It would be highly speculative to deduct from such a result, which is not uncommon, that in addition to the preoperatively diagnosed stapedial foot-plate ankylosis there also must exist in such a case an obstructive otosclerotic lesion in the region of the round window membrane. Histologically otosclerotic lesions in the round window niche, sufficient to interfere with the mobilization of the round window membrane by airborne sound, have been only rarely observed. Furthermore, the preoperative bone conduction hearing in such cases would not as a rule be found to be good enough to consider such an ear as suitable for the fenestration operation.

Points of Operative Technique which Influence the Restoration of Practical Hearing

The creation of a new vestibular fenestra to replace the functionally impeded oval window results in improved mobilization of endolymph by airborne sound which in turn can result in the restoration of practical hearing if the existing cochlear nerve function is adequate.

A tympanic air-space hermetically sealed with the tympanic membrane is essential following fenestration so that the endolymph could be mobilized by airborne sound.

The fact that practical hearing cannot be restored by fenestration in the presence of a perforated tympanic membrane is suggestive that a

Julius Lempert

hermetically sealed tympanic air space acts as a phase changer for the mobilization of the endolymph by airborne sound following the fenestration operation.

The newly created vestibular fenestra must be sealed with a viable tympano-meatal flap to protect the membranous labyrinth from degenerating with total loss of hearing resulting. Since mass influences the transmission of airborne sound to the perilymph space, the thinnest employable portion of the tympano-meatal flap should be facing the newly created vestibular fenestra.

The tympano-meatal membrane, though it is a continuous membrane, cannot conduct a sound wave from the tympanic membrane to the cutaneous portion which covers the new fenestra. The maintenance of continuity between the dermal layer of the tympanic membrane and that of the cutaneous portion of the tympano-meatal flap is essential for reasons apart from sound transmission. To assure the survival of the cutaneous portion of the tympano-meatal flap it is essential that it be nourished by the blood supply of the tympanic membrane.

The intermediate portion of the tympano-meatal flap becomes firmly adherent to bone between the tympanic air-space and the newly created vestibular window and therefore does not permit airborne sound striking the tympanic membrane to be transmitted effectively to the cutaneous portion sealing and covering the new fenestra. Further proof that mobilization of the tympano-meatal membrane as a whole and transmission of sound waves from its tympanic membrane to the fenestra segment does not take place following fenestration is the fact that practical hearing can be obtained when the cutaneous portion of the flap is accidentally severed from the tympanic portion, providing the cutaneous portion is replaced and adheres so that both the tympanic air-space and the newly created window remain hermetically though independently sealed.

Sound most likely enters simultaneously and independently both the round cochlear window and the newly created vestibular window and mobilizes the endolymph out of phase. It enters the round window through the tympanic portion of the tympano-meatal membrane and the new oval window through that part of the cutaneous portion of the tympano-meatal membrane which covers and seals it.

Since part of the tympano-meatal membrane remains adherent to bone and is therefore not mobilizable as a whole by airborne sound, the maintenance of the incus in its original position after removing the head and neck of the malleus can serve no useful acoustic purpose because it cannot act to enhance the mobilization of endolymph by airborne sound. The fenestra nov-ovalis operation has conclusively proven that just as good, or better, improvements in hearing are obtainable since incus is being removed.

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By the same token neither is the retention of the mucous membrane covering the tympanic portion of the facial canal necessary since it cannot result in better postoperative hearing.

The absence of an audiometric hearing improvement for airborne sound coupled with a negative response to the fistula test following the fenestration operation is usually the result of accidental surgical injury to the membranous external semicircular canal.

Postoperative Factors Influencing Restoration of Practical Hearing

A further loss in the hearing level following the fenestration operation in the presence of a negative fistula test may as a rule be attributed to severe postoperative labyrinthitis. Extensive injury of the perilymphatic trabecular blood-vessels, the creation of the fenestra in the presence of bleeding from the mastoid wound, the sealing of the fenestra with the tympano-meatal flap in the presence of bleeding, excessive postoperative inflammation or infection of the tympano-meatal flap, any of these could at one time or another be the responsible factor for such an untoward result.

However, postoperative labyrinthitis is today no longer a problem of this surgery. The meticulously careful performance of the fenestration operation with instantaneous surgical control of each and every bleeding point, when supplemented by daily administration of 300,000 units of penicillin for a period of ten postoperative days, has reduced the frequency of postoperative labyrinthitis with resulting further loss of hearing to less than 1 per cent. Penicillin, by reducing postoperative inflammation of the tympano-meatal flap to a minimum, in addition to its antibiotic action, has made this possible where all other means including the sulpha drugs have failed.

Postoperative Factors Influencing the Permanency of Restored Practical Hearing

A drop of the air-conduction hearing level in the three speech frequencies from the best postoperative level to a level below that necessary for practical hearing is as a rule representative of osteogenesis taking place within the fenestra rim. Though the hearing recession may not yet have reached the preoperative level it will ultimately decline to that level when bony closure of the fenestra is sufficiently advanced.

When the improved postoperative hearing level does not show a tendency to drop, a negative response to the fistula test is not a sign of bony closure. However, when the hearing level shows a tendency to drop below the practical level, a positive fistula test is no proof that

Julius Lempert

window is not undergoing bony closure, since a positive fistula test is obtainable even when the newly created fenestra is reduced to the size of a pin-point.

An otologist doing fenestration surgery cannot possibly acquire an appreciation of the complexity of the problems involved in this surgery, nor hope to improve himself or the surgery itself unless he insists upon revising and carefully studying his failures.

Repeated revisions of an osteogenetically closed fenestra do not as a rule result in a permanently open window, and endanger the well-being of the endolymphatic labyrinth.

Though the frequency of osteogenetic closure of the newly created fenestra has been greatly reduced since the general adoption and employment of the fenestra nov-ovalis operation its occurrence is, however, not yet as infrequent as some otologists believe it to be.

If this surgery is done with an open mind and with a critical evaluation of results the occurrence of window closures will inevitably be recognized. However, if one's mind is shut to this surgery and one is easily satisfied with the results obtained, then nothing but open windows will be seen.

Careful study of the newly created fenestra region in the post-fenestrated human subjects during revisions and the histologic observations made in the experimentally controlled post-fenestrated rhesus monkeys have shown that when osteogenesis takes place following fenestration it does so either in the region of the fenestra rim or in the perilymph space and also in both the fenestra rim and the perilymph space.

Further investigation of this problem has revealed that osteogenetic closure of the new fenestra is influenced mainly by :

i. *The site chosen for the creation of the fenestra.*—As a result of careful analysis of the observations made during revisions of osteogenetically closed fenestras in post-fenestrated human ears I developed the fenestra nov-ovalis technique which I described in November 1941 (*Archives of Otolaryngology*, xxxiv, 880-912).

By changing the fenestra site and moving it forward over the ampulla of the external semicircular canal and immediately anterior to it—which region forms the surgical dome of the vestibule—one of the great factors responsible for osteogenetic closure of the newly created fenestra is removed.

A fenestra created in this region communicates directly with the perilymphatic cisterna of the vestibule which is 3 mm. wide and 5 mm. deep. The formation of a fibrous connective tissue matrix which could aid and abet osteogenetic closure of the fenestra is less likely to take place in this region than in a fenestra created posterior to the ampulla of the external semicircular canal into a perilymphatic space the circumference of which is only about 0.8 mm.

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The universal adoption and employment of the fenestra nov-ovalis technique has for the first time in the history of this surgery sharply reduced the frequency of osteogenetic closure of the newly created fenestra.

2. *The inherent natural tendency for osteogenetic repair of the freshly injured histologic bony layers of the fenestra rim.*—In a discussion of osteogenesis following the fenestration operation in the human (*Archives of Otolaryngology*, 1940, xxxi, 711-779) I stated as follows:

From my observations during revisions of the fenestra, I was forced to conclude that new bone regeneration within the fenestra begins not in the periosteal but in the endosteal layer of the bony capsule and either may stop there, without involving the periosteal layer, or may eventually involve the periosteal layer of the bony walls of the fenestra.

Fig. 1 shows the three histologic layers of the labyrinthine bony capsule.

In the November 1947 issue of the *Archives of Otolaryngology*, xlvi, 590, Lindsay, in an analysis of his histologic observations of the results following fenestration of the labyrinth in the rhesus monkey, corroborated the observations which I have made in the human and stated as follows:

Failure to maintain an open fistula was in most cases due to the osteogenetic process which took origin from the endosteal surface at the margins.

Fig. 2 shows closure of the fenestra caused by osteogenetic repair of the endosteal bony layer only.

Neither the removal of the periosteal layer down to the enchondral layer of the bony fenestra rim, nor the removal of both the periosteal and enchondral layers of the fenestra rim down to the endosteal layer, prevents bone regeneration of the endosteal layer. Whether bony closure of the fenestra is the result of endosteal osteogenesis alone or osteogenesis involving all the three histologic layers is quite immaterial as to its effect upon the end-result. None of the three histologic layers is immune to osteogenesis. This has been amply demonstrated histologically in the rhesus monkey.

Scientifically controlled experimentation in the rhesus monkey has demonstrated that burnishing the fenestra rim with pure lead inactivates the histology within the freshly injured bony fenestra rim and prevents osteogenetic closure of the fenestra (*Archives of Otolaryngology*, 1947, xlvi, 512-527).

The use of lead burnishing in 800 consecutive patients since December 1947 seems to be corroborative of our experimental findings in the rhesus monkey.

In only 5 of the 170 cases which are now more than one year post-operative is there any apparent clinical evidence of bone regeneration.

Julius Lempert

However, one more year will have to pass before final evaluation of the lead-burnishing technique can be made.

Prior to the use of lead burnishing signs and symptoms of bone regeneration at the end of one year would be discernible in about 25 per cent. to 30 per cent. of the cases.

3. *Bone dust and bone slivers left behind in the region of the fenestra gap and within the perilymphatic space.*—In the surgical treatment for clinical otosclerosis, bone sand and bone splinters have always been by-products of fenestrating the bony labyrinthine capsule with the electrically driven burr. When the final endosteal bony layer is fractured inward and pulverized, bone dust and bone splinters are pushed in the direction of the perilymph space with most of them coming to rest upon the shredded endosteal membrane and the endolymphatic labyrinth. It has been a well-recognized fact that when these bone particles are not meticulously removed from the fenestra region they may stimulate and enhance the naturally existing tendency for osteogenesis in the freshly cut bony walls of the fenestra rim.

It is for this reason that various means of meticulously removing the fractured and pulverized endosteal layer of the bony capsule, which is seen resting upon the shredded endosteal membrane and the endolymphatic labyrinth, are being practised by otologists doing fenestration surgery.

However, every careful otologist practising fenestration surgery could not help but observe that in fracturing and pulverizing the endosteal bony layer of the fenestra region, bone dust and bone splinters unavoidably fell into the perilymph space and frequently disappeared beyond sight and reach.

Lindsay, after having made similar observations following experimental fenestration surgery in the rhesus monkey, stated in the November 1947 issue of the *Archives of Otolaryngology*, xlvi, 590, as follows :

The histologic examination has demonstrated that although at operation the technique appeared to be carried out faultlessly the complete removal of bone dust and fragments was rarely accomplished.

Attempts at removal of bone splinters from the perilymph space often result in severance of some of the perilymphatic trabeculae with haemorrhage from the trabecular blood-vessels into the perilymph space.

Figs. 3, 4, 5 and 6 show normally present perilymphatic trabeculae and trabecular blood-vessels in the vestibular labyrinth.

The endolymphatic labyrinth can easily be injured by a bone splinter left within the perilymph space or torn by attempts to remove such a splinter from the perilymph space.

Fig. 7 shows injury to endolymphatic labyrinth sustained as a result of bone splinters lost in the perilymphatic space of experimentally fenestrated rhesus monkey.

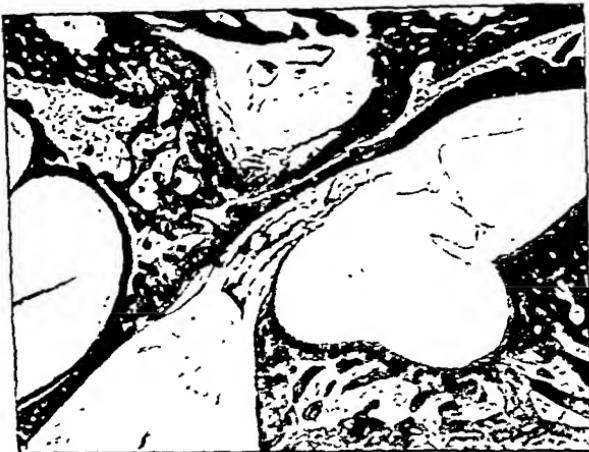


FIG. 1.

M.G. 10811 Right. Eight-month fetus. Three layers of bone form the otic capsule. A relatively thin layer of lamellar bone, the endosteal bone, immediately surrounds the membranous labyrinth. Next to this lies the more extensive enchondral layer, consisting of globuli interossei and marrow spaces. Most peripherally lies the periosteal layer of lamellar bone.

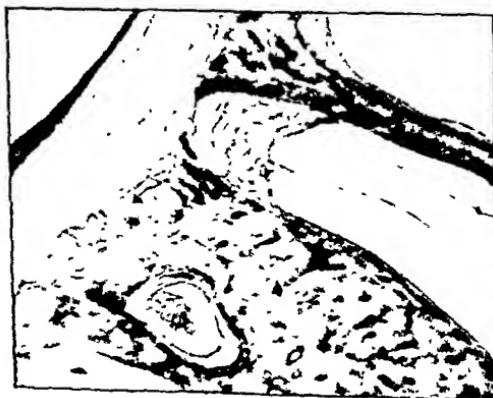


FIG. 2

Osteogenetic closure of fenestra in rhesus monkey by endosteal bone only. The periosteal and enchondral layers are not participating in the process of osteogenesis.



FIG. 3

Human 41-10811 Left Eight-month foetus Perilymphatic trabeculae and blood-vessels within vestibular labyrinth of eight-month-old foetus

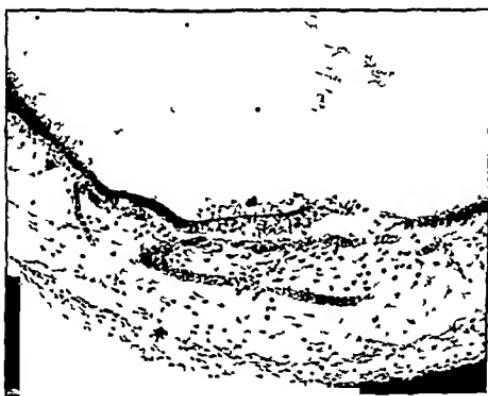


FIG. 4

Human 35 Left 254 Perilymphatic trabeculae and blood-vessels within external semicircular canal of human labyrinth



FIG 5

Human 10942 Right. Three-day infant Perilymphatic trabeculae and blood-vessels within vestibule of human labyrinth

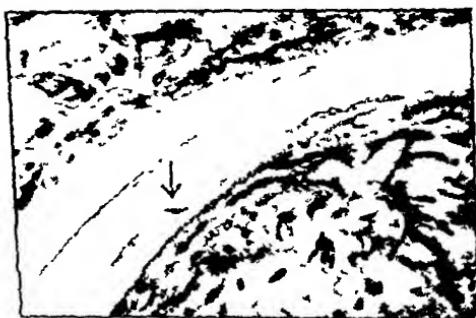


FIG 6

Monkey 1.1-21 Right. Perilymphatic trabecular blood-vessels within crus commune of fenestrated rhesus monkey



FIG. 7.

Monkey 24. Right. Exp. II. Injured endolymphatic labyrinth as a result of unavoidably lost bone splinters within the perilymph space of the external semicircular canal of a fenestrated rhesus monkey. Newly created fenestra is completely closed by osteogenesis.



FIG. 8.

Monkey 28. Right. Exp. II. Normally appearing perilymphatic space of fenestrated external semicircular canal in rhesus monkey. The endolymphatic labyrinth is seen in its normal position and uninjured. The perilymphatic trabeculae and blood-vessels remained uninjured and intact. Neither bone-dust nor bone-chips have entered the perilymph space. Bone regeneration has taken place only in the region of the fenestra rim.



FIG. 9

Monkey 42 Left Exp. III 6 months 1 week P.O. Fenestra of fenestrated rhesus monkey has remained patent showing absence of osteogenesis at fenestra rim. However, perilymphatic endosteal osteogenesis stimulated by unavoidably lost bone particles within the perilymph space can be seen.



FIG. 10

Monkey 40 Right, Exp. III. 3 months 2 weeks P.O. Almost complete obliteration of perilymphatic space of external semicircular canal in fenestrated rhesus monkey by endosteal osteogenesis which was apparently initiated by bone particles unavoidably lost in perilymph space during the process of fenestration. Osteogenesis has also taken place at fenestra rim.



FIG 11.

Monkey 23 Left Exp II Sec 500 Complete obliteration of perilymphatic space of external semicircular canal in fenestrated monkey by endosteal osteogenesis which was apparently initiated by bone particles unavoidably lost in perilymph space during the process of fenestration

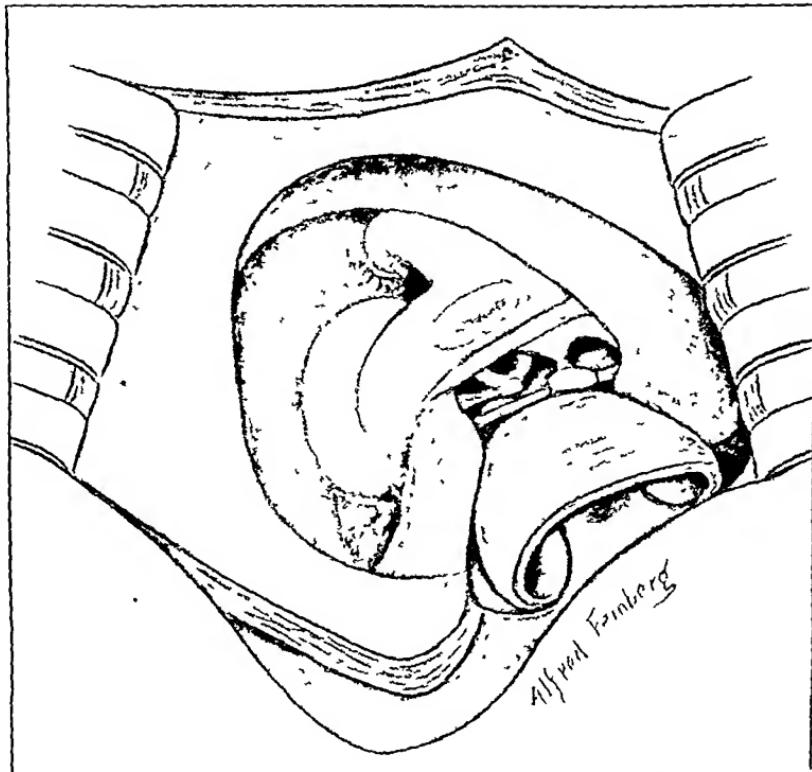


FIG 12

Step I Creation of an endosteal bone cupola on surgical dome of vestibule.

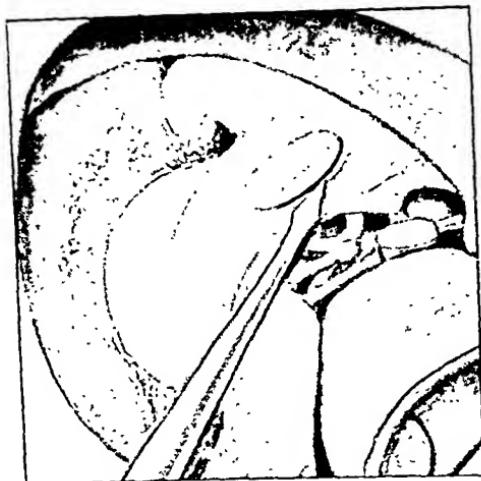


FIG. 13A.



FIG. 13B.

FIG. 13A and B.—Step II : Base of bony endosteal cupola is circumferentially incised.

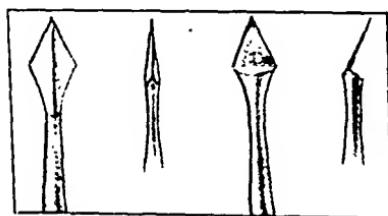


FIG. 13C.

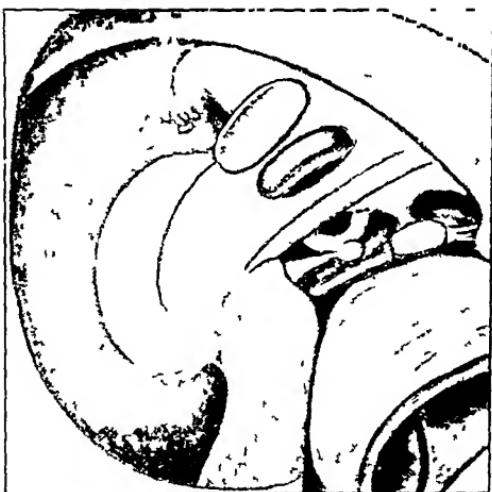


FIG 14A

Step III Eversion and removal of intact bony cupola to uncap perilymph space and expose to view endolymphatic labyrinth

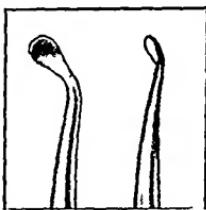


FIG 14B

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As a result of my careful observations in the performance of 450 revisions of fenestrated human ears, and the observations made in my histologic studies of the temporal bones in our experimentally fenestrated rhesus monkeys (*Archives of Otolaryngology*, 1947, xlvi, 512-527), I am convinced that bone dust and bone splinters entering the perilymph space are a much more serious threat to the hope of obtaining and continuously maintaining practical serviceable hearing as a result of fenestration surgery than bone dust and bone splinters resting in the region of the fenestra rim. This is so because bony fragments lost in the perilymph space are often not removable, while bone particles in the region of the fenestra rim can, as a rule, be completely removed.

In my postoperative clinical study of the 3,700 fenestration operations which I performed, I was able to observe two distinct clinical pictures both of which could be indicative and suggestive of an osteogenetic process having taken place postoperatively.

Clinical Picture Number One

A patient who had practical hearing restored and after having maintained this improvement at that high level for six months to a year suddenly begins to lose his hearing again and slowly his hearing acuity returns to the preoperative level and remains more or less at this level for some time.

In the vast majority of patients presenting this postoperative clinical picture, inspection of the fenestra region during revisions revealed that bone regeneration was limited to the fenestra rim of the bony labyrinthine capsule. When the newly formed endosteal bony growth was removed from the fenestra rim the hearing, as a rule, immediately improved and when osteogenesis did not recur, this improvement continued indefinitely. If osteogenetic closure of the fenestra took place once again the hearing again receded to the preoperative level.

In some fewer cases belonging to this clinical group I found no bone regeneration in fenestra rim but observed some narrowing of perilymphatic lumen as a result of endosteal osteogenesis. In these cases the hearing showed no improvement following revision and not infrequently the hearing continued to recede still further following the revision.

Clinical Picture Number Two

A patient who had practical hearing restored following the fenestration operation at the end of six months or so begins to lose his hearing improvement and more or less rapidly reaches the preoperative hearing level, but instead of remaining at that level for some time, his hearing continues to deteriorate to a level lower than it was preoperatively.

Julius Lempert

The findings grossly observed with the aid of magnification upon revision of the fenestra in such cases were usually of a more serious nature. Here the osteogenetic process was observed to have involved extensively both the fenestra rim and the perilymph space. The hearing in these cases did not improve following revision and continued its downward trend.

In analysing these findings in the two groups of post-fenestrated patients it became obvious that, since I have always meticulously removed all bone fragments visualized in the region of the fenestra gap, the osteogenetic process observed in the bony fenestra rim evidently was started by the inherently existing tendency for repair within the freshly injured bony histologic layers of the fenestra rim.

Fig. 8 shows osteogenetic process limited to freshly injured bony walls of fenestra rim in post-fenestrated rhesus monkey. The perilymphatic space appears normal with the endolymphatic labyrinth and trabeculae undisturbed.

However, the endosteal osteogenetic processes observed within the perilymphatic space during revisions of post-fenestrated human ears could not be explained on this basis, since injury to the endosteum-lined perilymphatic space is normally not part of my surgical technique. I therefore reasoned hypothetically that perhaps the perilymphatic endosteal osteogenetic processes which I observed in the human have been initiated by bone fragments having found their way unnoticed into the perilymph space.

Histologic studies of our experimental post-fenestrated rhesus monkeys have confirmed my suspicions that irremovable bone fragments, entering unavoidably and unnoticed and remaining in the perilymph space, do create endosteal osteogenesis in the perilymph space, a non-remediable condition which when occurring following the fenestration operation in the human is most damaging to the expected end-results.

Figs. 9, 10 and 11 show perilymphatic endosteal osteogenesis initiated by bone fragments lost unavoidably within the perilymph space of the post-fenestrated rhesus monkey.

In view of the clinical and operating-table observations, made in the human following fenestration of the labyrinth for clinical otosclerosis and the histologic observations made in the post-fenestrated labyrinths of rhesus monkeys, it became obvious that just as long as the creation of the fenestra nov-ovalis will involve the fracturing inward and pulverization of the endosteal bony layer of the labyrinthine capsule, some of the bone splinters and bone dust thus formed will frequently fall into the perilymph space and unavoidably disappear beyond retrieve within it.

In order to avoid the dire consequences and untoward end-results observed, which were caused apparently by non-retrievable unavoidably lost bone fragments within the labyrinthine perilymph space, I have

Lempert Fenestra Nov-Ovalis

gradually developed a new technique which I now exclusively employ for fenestrating the surgical dome of the vestibule without creating bone splinters and bone dust.

Bone-Dust-Free Fenestra Nov-Ovalis Technique

Step I.—Creation of an endosteal bone cupola on surgical dome of vestibule (Fig. 12).—Employing an electrically driven 1 mm. dental polishing burr the bony capsule of the surgical dome of the vestibule is gradually worn down to the endosteal bony layer, until it is thinned to a bluish-grey transparency. The bony capsule is then slowly and gradually worn down both antero-lateral and postero-lateral to the bluish-grey transparent area until a bluish-grey cupola of endosteal bone is created upon the surgical dome of the vestibule. The bone dust formed is constantly removed with saline and suction.

Step II.—Base of bony endosteal cupola is circumferentially incised.—In an absolutely blood-free surgical field, free from bone debris, the base of the cupola is incised as follows: The antero-lateral aspect of the base of the cupola is pierced with a small sharp perforating knife in the direction of the perilymph space. A linear incision is then carried from the perilymph space outward through the endosteum and endosteal bone along the entire circumference of the base of the cupola (Figs. 13A, B, C).

Step III.—Eversion and removal of intact bony cupola to uncap perilymph space and expose to view endolymphatic labyrinth.—With a flat spatula-tipped excavator the antero-lateral margin of the base of the endosteal bony cupola is engaged, gently lifted and everted in a direction postero-lateral to the fenestra and removed intact. The endolymphatic labyrinth, without having been disturbed from its normal position, is thus exposed to view (Figs. 14A, B).

Step IV.—Lead-burnishing of bony fenestra rim. To prevent osteogenesis from originating within the bone-dust-free freshly cut bony fenestra rim.—Pure lead is applied to the fenestra rim using a specially devised pencil holder. The leaded surface is then highly polished with an electrically driven smooth steel or gold burnishing burr.

Advantages

1. By employing this new technique for creating the fenestra nov-ovalis, the endosteal bony layer of the labyrinthine capsule is neither fractured inward nor pulverized. Since no bone particles are formed, none can be lost in the perilymphatic space. Therefore, neither the endolymphatic labyrinth nor the trabecular blood-vessels are ever in danger of being injured by bone splinters.

Julius Lempert

2. Since there are no bone particles to be lost in the perilymph space, endosteal osteogenetic processes formerly stimulated in the perilymph space by such bone particles are no longer possible.

3. By employing this technique the endolymphatic labyrinth always maintains its normal position within the perilymph space.

4. Fenestration surgery can thus be performed without traumatizing the endolymphatic labyrinth, the trabeculae and endosteal perilymphatic membrane.

By employing the bone-dust-free technique for creating the fenestra nov-ovalis the heretofore existing problem of how to best accomplish the removal of bone dust has been disposed.

Evaluation of Results following Fenestra Nov-Ovalis Operation

A uniformly agreed upon method of evaluating and reporting results is desirable. Careful postoperative testing with pure tone audiometry and its comparison with the preoperative audiometric reading are to date the most scientific means of evaluating the hearing result obtained.

A patient's postoperative claim of improved hearing acuity following the fenestration operation is acceptable only when his claim can be audiometrically substantiated, just as his preoperative claim of deafness was substantiated audiometrically.

Though it is true that preoperative pure tone air-conduction hearing for the 512, 1,024 and 2,048 frequencies at the 30 decibel level in a deafened ear does not necessarily always represent practical serviceable hearing for the spoken voice, it is only a half-truth, since it is also a fact that in such an ear the cochlear nerve function as represented by the bone conduction hearing is already at a level lower than the air-conduction hearing. However, a postoperative rise in the pure tone air-conduction hearing to the 30 decibel level, from a preoperative lower decibel level, following the fenestration operation is always accompanied by improved intelligibility for the spoken voice and is therefore representative of practical hearing. Such a pure tone decibel improvement and improved intelligibility could not have taken place if the bone conduction hearing representing the cochlear nerve function reservoir was not preoperatively adequate enough to permit the hearing restoration to the 30 decibel level.

Practical hearing improvements obtained following fenestration in clinical otosclerosis with preoperative evidence of unimpaired cochlear nerve function were as a rule permanently maintained at the practical level when the newly created window remained permanently open. There exists no clinical evidence of secondary cochlear nerve changes in these cases. However, since secondary cochlear nerve changes have only rarely been observed in the non-operated ear of such patients,

Lempert Fenestra Nov-Ovalis

definite conclusions that the fenestration operation prevented secondary cochlear nerve changes in these cases cannot as yet be drawn.

Results following this surgery, when estimated on the basis of written replies to a posted questionnaire, are completely unreliable in a large number of instances. Many deafened people who are socially and economically insecure and do not like to call attention to their infirmity by wearing a hearing-aid, also hesitate to admit their deafened state in writing, though they would gladly admit it in confidential consultation with their physician.

Following a successfully performed fenestration operation in one ear, an improvement of hearing in the non-operated ear which could be audiometrically substantiated in more than one audiometric reading has never been observed.

Conclusion

The Lempert fenestra nov-ovalis technique, whereby the fenestra is created in the surgical dome of the vestibule, when carefully performed can result in the restoration and permanent maintenance of practical serviceable unaided hearing in a high enough percentage of cases to render the surgical treatment of clinical otosclerosis acceptable to both the otologist and his patients.

There exists evidence now which suggests that the percentage of permanent practical hearing improvements is still further increased when the fenestra edges are treated with pure lead.

Also it is logical to assume that the bone-dust-free atraumatic creation of the fenestra will prove to be another great advance towards the final successful solution of the surgical treatment of clinical otosclerosis.

MUCOCELE OF THE FRONTAL SINUS

SOME NOTES ON ITS AETIOLOGY, PATHOLOGY AND DIAGNOSIS

By EDWARD F. STEWART (London)

Mucocele of the Frontal Sinus, usually unilateral, is an indolent, insidious, slow, progressive dilatation of the frontal sinus, previously the site of an old infection and resulting from an accumulation of mucus and/or inspissated debris. It is invariably, *per se*, a chronic condition, but when it becomes infected it presents as an acute case—indeed it frequently escapes diagnosis until secondary infection supervenes. The patient is usually in the age period 20-60, although a case has been reported in a boy aged 13 (Rosenberger and Kinney).⁵ The average age in twenty cases was 42. Males and females are equally affected.

Pathology. Its origin is not universally agreed upon and there are many theories, but it is generally conceded that it invariably has as a basis for its pathology a low grade inflammation which may have persisted after one or more attacks of acute pansinusitis, usually mucoid. This results in an intermittent or continuous obstruction of the fronto-nasal duct. The following theories are quoted for consideration : ^{1,6,7}

1. A retention mucous cyst, following upon an intermittent or continuous obstruction of the fronto-nasal duct, leading to a retention and distension by the accumulated secreted mucus. The swelling acts as a space-occupying lesion which continues to grow, expanding the sinus cavity and invading the surrounding structures, absorbing by pressure atrophy the thin, paper-like bones which encompass it in all directions but one. Because these surroundings are of live bone and because of the continuous process of remodelling in which new bone is continually being laid down and absorbed (as shown by Madder feeding experiments and more recently by the exhibition of radio-active calcium and phosphorus "tracers"), the bone, though it becomes attenuated and bulged outwards in all directions, nevertheless undergoes a dynamic process and not a passive one due to distension by pressure from within the sinus. Admittedly this is the stimulating factor.

2. Eggston and Wolff (1947, p. 672)¹ attribute the formation of a mucocele to a cystic degeneration of the mucous membrane of the sinus with an expanding tumour formation, most likely to result from a pansinusitis which has at some time almost completely resolved, but leaving in its wake thickened lining mucous membrane and resultant intermittent partial obstruction to the fronto-nasal duct.

Mucocele of the Frontal Sinus

3. The mucocele is invariably unilateral and lined by pseudo-stratified ciliated columnar epithelium showing fibrosis and chronic inflammatory reaction in which there are only isolated islands of cells containing cilia. In this observation may be the clue to the source of the mucocele. Proetz has emphasized that for the movement of mucus towards the natural ostium of a sinus and its expulsion therefrom, normally functioning ciliated epithelium is essential. Destruction of the cilia alone, i.e. necrosis following from an acute infection of the sinus with failure of regeneration, which in time may be due to an underlying chronic periostitis or osteitis, would prevent the expulsion of the mucus which would then accumulate and form in time a mucocele.

Note. Would not mucoceles be more common if this were so? This is the pathology of a lung abscess or bronchiectasis where the drainage is not dependent like that of the frontal sinus.

4. An adenoma of one of the racemose seromucinous glands which predominate in the region of the fronto-nasal duct and which are rarely found elsewhere in the frontal sinus mucous membrane.²

5. Swelling of the mucous membrane in the middle meatus.

6. Polypus in the middle meatus.

7. Trauma (instrumental, or fracture in the region of the naso-frontal duct). Howarth reports five cases with a history of injury.⁴

8. Blockage to fronto-nasal duct by an enlarged normal or abnormal fronto-ethmoidal cell.

9. Howarth has reported a case of a large osteoma causing a mucocele of the frontal sinus and maxillary antrum.³

Contents of the mucocele may be :

- (i) Mucus, thick, clear.
- (ii) Mucus, with cholesterol crystals, clear.
- (iii) A thick, yellow, cheesy mass (as in Case III).

The original purulent secretion, unable to escape, becomes stagnant. Later the fluid is absorbed and the pus cells undergo a degenerative process. Microscopic examination shows an amorphous mass with cholestrin crystals. The contents on culture are invariably sterile.

When the mucocele has commenced to extend and has already distended the frontal sinus, as already mentioned (this is a dynamic process on the part of the bone); there comes a time when the bone absorption cannot keep pace with the laying down of new bone and the thinnest walls at first become eroded. The septa are flattened out, the inter sinus septum is pushed over to the opposite side and the floor of the frontal sinus is ballooned down to form a swelling in the roof of the orbit. In this way the entire roof of the orbit may atrophy.

Edward F. Stewart

The roof of the frontal sinus may undergo a pressure atrophy, exposing a large area of dura. The thick anterior wall does not usually yield so that the swelling spreads in a direction upwards (into the anterior cranial fossa), downwards, encroaching on the orbital cavity (often displacing the bulb), medially across the mid-line into the opposite frontal sinus, backwards towards the sphenoidal region.

The mucocele may remain confined (a) to the frontal sinus, or (b) extend outside its confines.

(a) *Intra-frontal.* Mucocele may be limited to the frontal sinus without involving the orbit. The cavity is distended and the dura may be exposed by pressure destroying the walls of the frontal sinus. A swelling forms below the frontal sinus and in the orbit, displacing the eyeball downwards and outwards. The walls of the sinus may finally atrophy from pressure, becoming thinned and imparting the phenomena of eggshell crackling on palpation. The swelling may reach a very large size.

(b) *Mucocele of the Fronto-orbit.* This is a rare condition. It may arise from the frontal sinus and/or the anterior ethmoidal cells. The cavity of the frontal sinus may be dilated by an intra-frontal mucocele containing a serous or mucinous exudate. It results from intermittent obstruction of the naso-frontal duct over a long period. The mucocele penetrates through the floor of the frontal sinus at its inner and most posterior part, where it is thinnest. This indolent, painless swelling slowly develops on the inner wall of the orbit, deep to the inner canthus. The swelling is lobulated and sessile. Suppuration extending from the frontal or ethmoidal sinuses always penetrates through this weak area—in the postero-medial aspect of the floor of the frontal sinus. Here the ethmoid cells abut on the frontal sinus and here also is the aperture for the transmission of the anterior ethmoidal artery. This "perforating" spot may be palpated in the upper part of the medial wall of the orbit, above the inner canthus. Tenderness is sought for here in cases of suspected frontal sinusitis.

Clinical Aspects

In cases of mucocele of the frontal sinus the nasal passages are, as a rule, normal in appearance, and the maxillary antrum on the same side, on lavage, returns a clear unchanged fluid. Such negative rhinoscopic and antral lavage findings are the rule, even if the mucocele is suppurating. The explanation is :

- (a) The formation of a mucocele has taken a considerable time to develop, and
- (b) In the meantime the remaining part of the original pansinusitis has resolved completely.



FIG. I.

X-RAY OF CASE I.

1. Globular distension of the sinus.
2. Partial absence of intersinus septum: the lower part can be distinguished
3. Upper part of intersinus septum ballooned across into opposite sinus.
4. Destruction of medial part of orbital wall on right side.



FIG. 2.

X-RAYS OF CASE II

1 The left frontal sinus is distended the septa flattened out the intersinus septum is displaced across the mid-line to the opposite side there is destruction of the inner and upper wall of the orbit The fluid level in the left maxillary antrum is the fluid level resulting from antral lavage



FIG. 3.

X-RAYS OF CASE II.

² The second X-ray was taken four years later, during which time the patient had had one relapse a year after the original operation and which had been cured by simple intranasal drainage



FIG. 4.
CASE III
Original Photograph

Mucocele of the Frontal Sinus

Here, when the mucocele is infected, we observe an analogy with an acute panotitis when the middle-ear infection resolves completely, yet some weeks later a subperiosteal abscess develops, showing that an ectopic nidus has smouldered on to give rise to an abscess.

Because of the extraordinarily slow course taken, pain is rarely a complaint, indeed many cases, and one of those cited, were troubled with diplopia and presented themselves at an ophthalmic hospital. It is indeed remarkable that the facial disfigurement does not prompt these patients to seek advice earlier. They do not as a rule present themselves until the condition is well established with considerable displacement of the eyeball. Early cases are invariably overlooked (many surgeons are under the impression that mucocele of the frontal sinus must manifest itself by external swelling before the diagnosis is made) until it has extended outside the normal confines of the frontal sinus when it presents as an orbital swelling; then its simulation of a neoplasm may be the cause of much concern. When the mucocele becomes secondarily infected and the intense unremitting supra-orbital neuralgia fails to respond to the usual methods, it drives the bereft sufferer from specialist to specialist until the correct diagnosis is established and prompt drainage is instituted.

A careful perusal of the preceding history will reveal that the patient has suffered from periodical (but transient) attacks of frontalgia. This may have been diagnosed as a catarrhal frontal sinusitis and treated as such. The frequency of the attacks, coupled with the absence of physical signs on anterior or posterior rhinoscopy, supported by a negative antral puncture, results in the patient being labelled with the lapse of time—neurotic—until the condition becomes more manifest cosmetically. But, the day comes when a swelling suddenly appears in the orbit, the pain becomes intensified and continuous and drives the sufferer to distraction. It is then that another source of aid is frantically investigated.

Yet there are many pointers to early diagnosis before the sinus is grossly distended and before the mucocele suppurates.

1. Recurrent attacks of periodic supra-orbital neuralgia in a "dry nasal cavity" with a maxillary antrum which lights up well on transillumination and which returns a clear fluid on lavage.

2. The affected frontal sinus (whose size, shape and distribution can only, and must, be ascertained by radiography) is dull on transillumination.

3. The X-ray will show a frontal sinus unusually large with the normal septa either completely flattened, or even obliterated. This latter is seen only in a distended sinus which tends to assume a globular form. The inter-frontal sinus septum is often seen displaced across the

midline, being ballooned into its fellow of the opposite side. The swelling when large, is alarming (usually more so to the surgeons than to the patient) and the resemblance to a malignant neoplasm is complete, even to the obvious bone destruction resulting from ultimate pressure atrophy. Indeed, in Case III (Mrs. E.C.) and Case II, the radiologist insisted on a diagnosis of malignant neoplasm.

4. In some cases, if the mucous membrane of the middle meatus of the nose is shrunk by the application of a cocaine and adrenaline spray, a stream of mucus or pus may be expressed into the middle meatus by pressure over the swelling in the roof or inner wall of the orbit—this is diagnostic.

5. Occasionally pressure over the swelling in the orbit will produce a gush of pus into the middle meatus and the swelling may collapse completely, though temporarily as in Case I.

6. Unilateral proptosis developing insidiously may for some time be the first sign of an otherwise symptomless (even by radiography) mucocele of the orbit.

7. Eggshell crackling on palpation is occasionally elicited.

Differential Diagnosis

The swelling simulates most closely a malignant neoplasm, but the diagnosis has to be made from other tumours and inflammation likely to arise in the tissues in that region.

Complications

Are mainly those due to infection and/or pressure.

(a) Suppuration and associated spread to :

1. Frontal bone (Osteomyelitis).
2. Orbit and its contents.
3. Meninges.
4. Brain.
5. Venous sinuses.

(b) Pressure on surrounding structures, manifest by paryses of ocular muscles by direct pressure and by pressure on the nerves supplying them. Blindness due to pressure on the optic nerve, compressing it and its contained central artery of the retina.

When the mucocele suppurates, the clinical picture is typical. The supra-orbital neuralgia, hitherto intermittent, now becomes *continuous and excruciating* : the swelling increases in size suddenly and becomes

Mucocele of the Frontal Sinus

exquisitely tender and even larger. The supervention of this sequence of events is characteristic and sufficient to drive the unfortunate individual to the succour of surgery.

CASE I.—Suppurating mucocele of the frontal sinus: operation: intranasal drainage: recovery.

MRS. A.S., 22.8.40. A female aged 50 complained of headache and swelling in the region of the right eye for six months. The swelling had been gradually increasing in size and the eyeball was relatively displaced downward and outwards. There was no constant diplopia. Tenderness was elicited on gentle pressure above the inner canthus on the medial wall of the orbit. On the previous day the headache had eased with the simultaneous discharge of a large amount of pus from the nose (a symptom only elicited on questioning in regard to the presence or absence of nasal catarrh, which as a general rule was denied). There was no chemosis or proptosis. Offensive pus was observed in the right middle meatus high up. Pressure on the external swelling failed to produce pus flow into the nose, though the middle meatus was indeed not packed to shrink it up and elicit this sign. X-ray demonstrated a large frontal sinus thrown into one with the left side. The upper orbital margin on the right side was eroded. Both antra were opaque.

Operation. The right maxillary antrum was explored and revealed foetid pus. This was drained by an intranasal antrostomy. Proof puncture and irrigation of the left antrum returned a clear fluid. The right middle turbinate at its anterior attachment was severed with scissors from the lateral wall of the nose. This was intended as the first stage to amputation of the anterior end of the middle turbinate, but it led to a huge gush of foetid pus from the frontal sinus, the external swelling disappearing completely. The offensive pus filled the nostril and was aspirated away. The anterior end of the middle turbinate was then removed by Luc's forceps and the largest available frontal sinus bougie easily entered the frontal sinus, a large aperture being noted, i.e., the fronto-nasal duct had been dilated. The tip of the bougie could be easily palpated through the skin above the inner canthus and the actual breach through the orbital wall distinguished.

A week later the patient was exceedingly well in herself. There was no orbital swelling to be distinguished. The large size frontal bougie entered the sinus easily through the dilated fronto-nasal duct.

Subsequent progress. On at least two occasions in the following years the swelling recurred, but rapidly resolved on aspiration through the fronto-nasal duct, which rather goes to prove the theory enunciated in the previous notes that destruction of the cilia alone would prevent the expulsion of the mucus which would accumulate, stagnate and form, with the passage of time, a mucocele.

CASE II.—Suppurating mucocele of left frontal sinus, preceded by intermittent attacks of frontalgia attributed to nerves. Orbital swelling: external operation: recovery with a relapse one year later, cured by intranasal drainage. No recurrence in subsequent three years.

Edward F. Stewart

MRS. B., Aet. 50. 18.2.43. Was under treatment for a considerable period for intermittent attacks of left supra-orbital neuralgia, unaccompanied by any symptoms or signs, clinically, radiologically or on proof puncture of the maxillary antrum on the same side. Only that week, seen by her usual medical attendant, the attack of neuralgia was ascribed to nerves. When first seen her complaint was left supra-orbital neuralgia, previously intermittent, had now become continuous and lancinating for three days. It interfered with her sleep and did not respond to the usual remedies. She had not at the time, or previously, any symptoms which might lead her to suspect nasal or sinus disease, and, as mentioned, there were no nasal signs. There was now a noticeable exquisitely tender swelling at the upper and inner part of the roof of the orbit, displacing the eye downward and outwards. There was some diplopia. This orbital swelling, to which the radiologist's attention was now drawn, was reported by him, after perusal of his plates, to be a malignant neoplasm, despite the clinical diagnosis of a suppurating mucocele of the frontal sinus.

Operation. An external frontal sinus operation drained a suppurating mucocele of the frontal sinus. A large drainage tube was passed through the fronto-nasal duct into the nose and sutured to the external incision to retain it in situ. The external wound was sutured.

Though the first week of convalescence was complicated by an attack of acute glaucoma in the opposite eye, for which an emergency operation was performed, and in the second week by an acute haematemesis, recovery was complete.

Subsequent progress. At the end of the first year the swelling recurred following a cold. The attack resolved with nasal drainage. For the following three years she has been under constant supervision. There have been occasional slight attacks of left supra-orbital neuralgia, but the nasal symptoms and signs have all the time been conspicuous by their absence.

1948. Still keeps well.

CASE III.—Suppurating mucocele of the right frontal sinus of unusually large dimensions, encroaching extensively on the surrounding structures, simulating a new growth: external operation with nasal drainage. Recurrence of the mucocele: marsupialization: recovery.

This case is recorded, not only because of the unusual dimensions of the mucocele and the degree to which it had developed before the patient sought advice, but the method of dealing with such a case by marsupialization of the mucocele.

MRS. E.C., Aet. 50, 1946. Her medical attendant had referred her to the Central London Ophthalmic Hospital who, in turn, had referred her to the Royal National Throat, Nose and Ear Hospital, on account of an orbital swelling which had grossly displaced her right eye downwards and outwards. There was diplopia and right supra-orbital neuralgia, not severe, and a general headache. This was only of comparatively recent origin, though the swelling had been gradually increasing in size for the previous four years. There was a bilateral nasal discharge of frank pus. The external appearance resembled

Mucocele of the Frontal Sinus

that of a malignant growth and the radiologist's report was: "that in view of the extensive destruction of the bone, malignancy cannot be excluded." It was surprising to what extent the mucocele had developed and the long period elapsing before the patient sought advice. The photograph shows this gross facial disfigurement.

First operation. The mucocele was drained through an external fronto-ethmoidal operation by a large rubber drainage tube passed into the nose. The sinus contained thick, cheesy material which, on microscopic examination, was found to consist of amorphous debris containing cholestrin crystals. It was sterile on culture. This was in sharp contrast to the contents of both maxillary sinuses, which contained frank pus. The right maxillary sinus was drained by a simple intranasal antrostomy. The tube was stitched in position. The aperture made in the frontal-sphenoid region was at least 12 mm. in diameter, and the drainage tube was of similar dimensions. This tube was stitched in position and retained there for four weeks when it was withdrawn, but again, in this case, in spite of the large aperture for drainage, the suppurating mucocele gradually returned within a few weeks.

It is interesting to note in X-ray "C", taken five weeks after operation, that drainage was incomplete because a fluid level is shown, even with a frontal sinus bougie in position, and it would seem that the fronto-nasal stoma made at operation was not in the most dependent part of the sinus—or can we again ascribe this to retention of secretion and exudate owing to lack of cilia in the region of the artificial stoma?

Penicillin therapy was instituted and carried on throughout this period.

Second operation. In view of the recurrence of the mucocele, a second operation was planned in which it was proposed to marsupialize the frontal sinus, and accordingly the external incision was reopened and a large bore rubber drainage tube again inserted through the nasal cavity into the frontal sinus and saturated in situ. The external incision was left widely open and packed with bipp gauze. The gauze was left in situ for a week and changed weekly, being regularly replaced until the edges had epithelialized over, leaving a large stoma opening on to the surface, i.e., a large fistula was formed. This took place within two months. It should be noted that it is not a simple procedure to make this fistula as the wound is constantly tending to close and needs constant supervision. The drainage tube into the nose was retained in position and then removed.

Subsequent course. Within a few weeks the frontal sinus was clear of secretions and the inflammation of the mucous membrane resolved completely. It was interesting to observe the transition, the most striking feature being that as the lining of the new stoma in the region of the fronto-nasal duct was rested and the constant passage of infected material diverted from bathing it continuously, this stoma appeared gradually to become epithelialized with mucous membrane indistinguishable from that lining the remainder of the sinus, which was essentially normal. There was no stenosis of this stoma observed during the period.

A trickle of pus was observed from time to time emanating from a minute perforation in the intersinus septum and the left frontal sinus (full of pus) was

Edward F. Stewart

drained by external operation. Attempts were made to keep this incision open, but this did not meet with success and the wound healed over.

Present condition. The right frontal sinus remains healed and dry. It is visible through the stoma which persists. The deformity is very slight and the patient wears a small pluglet of wool over it (flesh coloured like elastoplast finger dressings) and wears spectacles. It is now proposed (18 months later) to close the stoma by plastic. The eye has returned to its normal position and with that the diplopia has disappeared.

By marsupialization of the sinus in this way one feels that one has considerable control over the situation in general and especially over the healing of the stoma into the nose without stenosis, and also over the chronic condition of the sinus which so often is the dreary story of interference with the fronto-nasal duct. Would not this be the ideal method of dealing with chronic suppuration in the frontal sinus in order to avoid those cases who are always with us and whose faces send a cold chill down the spine when they appear so constantly in the out-patient department, and who so frequently find their way into the theatre for further operative interference?

The cosmetic defect of the fistula would, we realize, not be permitted by many, though it is only temporary. The subsequent reopenings, could they be forecast by the patient, would amply repay this bold decision to consent to the procedure at the outset. It is less conspicuous than an even row of tombstone-like dentures.

My grateful thanks are due to Mr. N. Asherson for his help and encouragement and for permission to quote the cases all of which were under his care.

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FIG. 5.

CASE III. ORIGINAL X-RAY (A) PRE-OPERATION.

(a) The right frontal sinus enormous in size, extends from the zygoma to well beyond the mid-line: towards the vertex for over 2 ins. and as far as the ethmoid: the sinus is dilated globular in appearance: all septa are flattened out. The entire roof of the orbit and part of the medial wall of the orbit (chronoid) have been absorbed. The sinus is cloudy: there is no fluid level. The left frontal sinus is small, but it is also infected.

15.10.46.



Fig 6

CASE III ORIGINAL X RAY (b)
(b) Lateral view to show the dilatation of the sphenoid sinus
extending to the sphenoid sinus

Fig 7.

CASE III X-RAY (c)

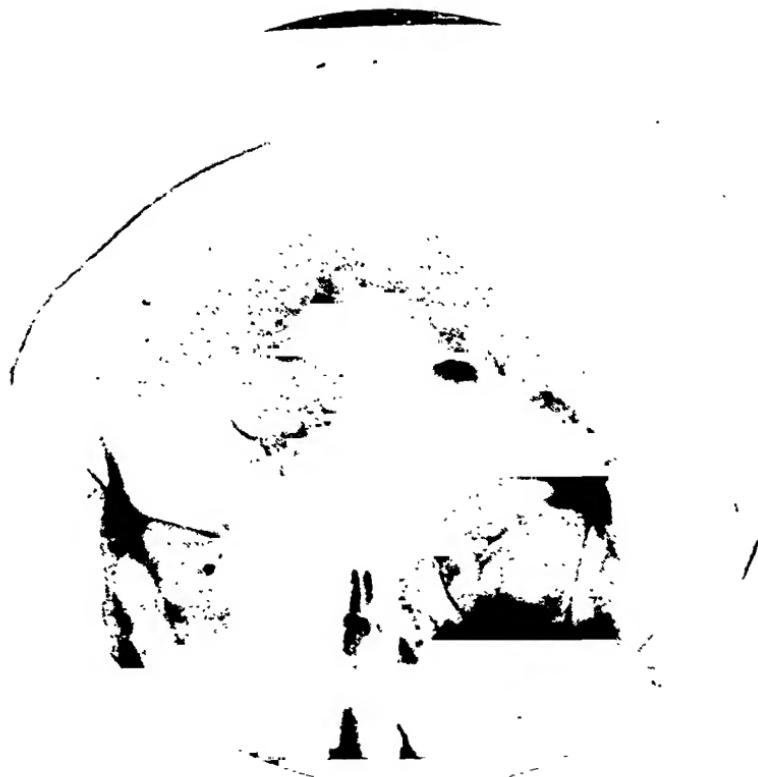


FIG. 8.

CASE III. X-RAY (D).

After second operation to produce marsupialization of right frontal sinus, showing Bipp plug in situ.

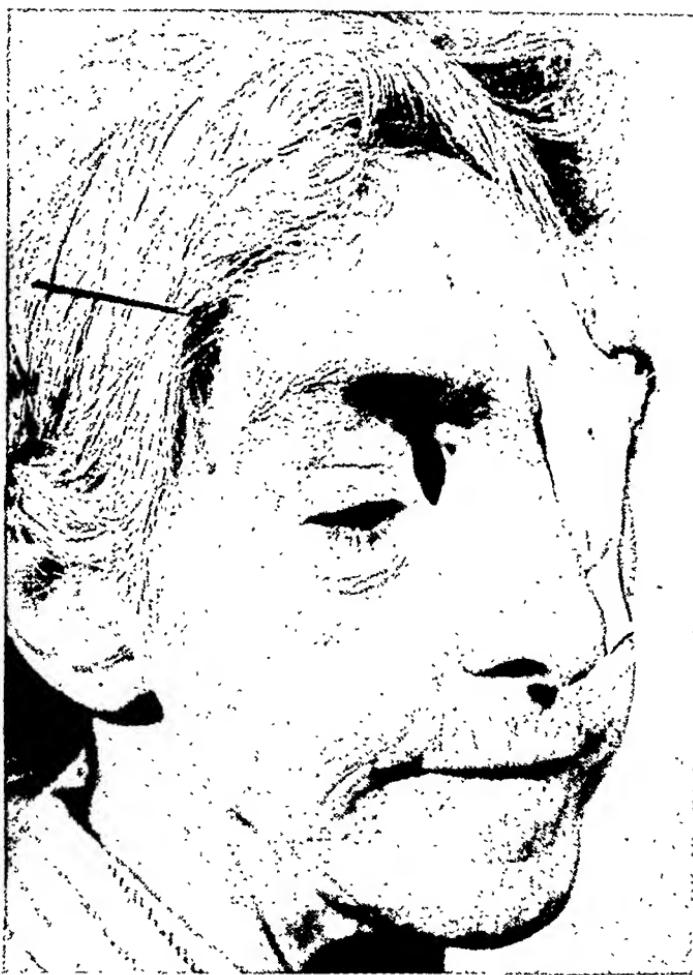


FIG. 9.
CASE III.

Photograph showing patient with fistula into right frontal sinus and a dressing over the left external frontal sinus operation.

STAPEDIOTOMY (STAPEDIUS TENOTOMY)

By L. R. S. TAYLOR and G. H. BATEMAN (London)

In 1945 H. B. Perlman* showed that when the ossicular chain of the middle ear is broken, the stapedius muscle acts unopposed and tilts the foot of the stapes firmly into the oval window.

In chronic suppurative otitis media this experimental condition is often reproduced. The incus is partly or wholly destroyed by the disease process. The stapedius acting unopposed tilts the stapes footplate into the oval window so damping down auditory stimuli which would normally cause the oval window membrane to vibrate. It may be supposed that continued bathing of the muscle in purulent fluid causes a spasm of the muscle and in due course devitalization and fibrosis of its tissue. The stapes is then firmly fixed in the oval window and a permanent conductive impairment in hearing results.

If the stapes can be mobilized this hearing loss should be in part at least recovered. Division of the stapedius tendon during radical mastoidectomy allows this mobilization to occur.

It has been pointed out that when the oval and round windows carry the same mass then there will be no phase difference in sound reception. This will result in very severe loss of hearing by air conduction. In dividing the stapedius tendon therefore, a portion is left attached to the stapes and the mobilized stapes is left *in situ*. The oval and round window membranes will then be of different inertia. In one case in a series of six the stapes was removed completely leaving an intact oval window membrane, and in a second case one crus of the stapes was fractured. The former case became very severely deaf to air conduction and the latter showed no improvement in hearing. Of the remaining four cases, three showed a dramatic improvement in hearing and one showed no change. Audiograms of one case are shown.

Using magnifying spectacles the tendon is defined and divided from above downwards. We have found a Furness myringotome to be a useful instrument for the procedure. The tendon is surprisingly tough.

The following is the case history of a man who illustrates successful stapediotomy in one ear (Right) and the effect of destruction of stapes by disease in the other ear (Left).

Mr. R. P. was blown up by a mortar bomb in 1944 and concussed. This resulted in bilateral otitis media with the right ear almost useless and the left hard of hearing. He first attended St. Thomas's Hospital November 13th, 1947, when the right ear was seen to be filled with

**Laryngoscope*, iv. 337-348, July, 1945.

granulations and had a smelly discharge. Left otorrhoea was also present but was not so offensive in character. After attending the chronic ear clinic daily for a month with little improvement a right radical endaural mastoidectomy was decided upon and done on January 13th, 1948. The long process of the incus had been destroyed by disease. The stapedius tendon was well seen and divided. The stapes was mobile. No fistula was seen in the external canal although a pre-operative fistula test had been positive. Postoperative penicillin was given and the ear became dry four weeks later. Preoperative and post-operative audiograms are shown. The patient heard speech with the right ear for first time since wounding. Left otorrhoea continued, therefore a left endaural modified radical was done on March 9th, 1948. At that operation the stapedius tendon could not be defined. This ear was revised because of continued otorrhoea on August 8th, 1948 and converted to a radical. The middle ear was closely scrutinized. No stapes was visible although a small portion of bone overhanging the oval window was seen and removed. A final audiogram taken on November 21st, 1948, is shown. The left ear is now useless for hearing. It will be seen that bone conduction in the right ear has remained unaltered although air conduction has improved by 15-20 decibels for the speech frequencies. The left ear shows a marked falling off in both air and bone conduction, the latter possibly on account of a serous labyrinthitis due to irritation near the oval window although there were no other clinical signs of this.

LEFT EAR

	128	256	512	1024	2048	4096	8192	9747	
3.1.48 A.C.	35	40	40	60	60	70	70	65	Before operation
29.1.48	45	55	55	60	65	65	55	65	After opn. Rt. Ear
21.11.48	↓	↓	90	95	90	100	↓	↓	After revision on Lt. Ear
3.1.48 B.C.			45	40	45	45	60	55	
21.11.48			50	↓	↓	↓	↓	↓	

RIGHT EAR

	128	256	512	1024	2048	4096	8192	9747	
3.1.48 A.C.	60	80	85	90	95	100	↓	↓	Before operation
29.1.48	55	75	75	70	70	75	75	↓	After operation
21.11.48	65	70	70	70	70	95	↓	↓	10 months later
3.1.48 B.C.			45	50	55	55	55	60	Before operation
21.11.48			50	40	45	45	60	60	10 months post- operative

CLINICAL RECORD

A CASE OF LIPOIDOSIS SIMULATING DOUBLE MASTOIDITIS

By A. S. HANDOUSA BEY; F.R.C.S.,

Professor of Oto-laryngology Foad 1 University, Cairo, Egypt

DISTURBED fat metabolism is believed to give rise to a number of diseases having distinguishing clinical and pathological features, grouped under the term "lipoidosis, lipoid granulomatosis or reticulo-endotheliosis".

The principal diseases in question are :

1. Gaucher's Disease.
2. Niemann-Pick's Disease.
3. Hand-Schuller-Christian's Disease.

These three diseases have in common the characteristic feature of storage of lipoid material in large cells derived from the reticulo-endothelial system (foam cells with vacuolated cytoplasm) ; the type of lipoid principally stored determines the type of disease in question.

In Hand-Schuller-Christian disease, the principal lipoid stored is cholestrin and its esters.

Lipoidosis on the whole is uncommon and in all the three diseases named above the storage of lipoid may take place in the bones of the skeleton as well as in certain organs producing characteristic radiological appearances ; but it seems that the Hand-Schuller-Christian type is the only one that gives such manifestations in the bones of the skull. In this type of disease the skull bones may even escape, or at least the lesion may not be radiologically demonstrable.

The distribution of skull lesions in the following case seems unique ; there is a bilateral almost symmetrical defect in the temporal bones, a distribution I have not seen recorded before.

Mme. M.M., 62 years old, first saw me on *January 27th, 1947* for a persistent bilateral ear discharge of three years' duration, and eczema of both meati as well as the retro-auricular regions, which has developed only during the last three months. Ordinary medical treatment including deep radiotherapy for the eczema was tried with no benefit.

The patient was so deaf that the past history was very difficult to take but it was clear that she was for a long time subject to dental trouble, especially in the right upper set of teeth.

She was tall, well built, very fat, having a high-toned voice ; the eyelids contained yellowish xanthomatous masses ; the face was symmetrical and free of signs of facial nerve lesion.

On syringing the sero-sanguineous ear-discharge, the washings although free of scales contained shining particles that proved on examination to be cholestrin crystals.

A. S. Handousa Bey

The meati were greatly narrowed and showed so much deep sagging that the drums could not be viewed.

Under the scalp hair, over the base of the mastoids, there was on each side a doughy swelling, which the patient was quite ignorant of. These two swellings were not tender and did not show any sign of acute inflammation. Pressure on these swellings induced a flow of thick brownish discharge containing yellowish granules from the meati.

The paranasal sinuses were slightly opaque to transillumination.

There is generalized gingivitis with loosening of the remaining unextracted teeth.

Hearing tests showed that air conduction was absent and only traces of the bone conduction were left on each side.

Pulse and temperature were normal.

The previous data show clearly that we were not dealing with an ordinary case of mastoiditis and further study of the case seemed of immediate value.

General examination revealed eczema under the breasts, absence of xanthomata except in the eyelids. The chest was free; the liver and spleen did not show any demonstrable enlargement.

The *urine* was collected and found to amount to 2.900 c.c. per 24 hours, it was alkaline, of very low specific gravity (1002), containing a very faint trace of albumen but free of sugar and the Bence-Jones reaction was negative.

It was realized then that the patient was suffering, too, from diabetes insipidus and apparently she was not troubled by the polyuria. In fact, she never admitted it until the urine was collected and found excessive in quantity and it was found that she had had it for a long time.

Wassermann's reaction was negative, and the blood cholesterol, was 120 mgms. per 100 c.c. of blood. (The normal as indicated by the Biochemist is 150-160 mgms. per 100 c.c.)

Radiologically. The osseous system revealed curious bony changes principally present in the skull:

1. The pelvis, lumbar spine and both femera aside from the senile changes usually present at such an age, showed a peculiar generalized haziness masking the normal bony texture giving it a homogenous "ground glass appearance".

2. The skull showed similar changes, but the prominent feature was the presence of extensive bilateral almost symmetrical defect in the temporal bones. Figs. 1 and 2, having an irregular but sharply cut margin, which shows no bony reaction. The superior maxilla shows a similar defect on the right side.

The sutures appear somewhat widened, but the sella turcica is radiologically free; the paranasal sinuses are slightly opaque.

3. The lungs were clear.

The multiple bony lesions confirmed what we came to before that we were not dealing with an ordinary case of mastoiditis and favoured the diagnosis of a generalized process of disease. The negative W.R. and the absence of any reaction at the margins of the bony defects excluded syphilis, also the negative Bence-Jones reaction was against myelomatosis.

Clinical Record

The presence of xanthomata in the eyelids, the chronic eczema of the skin together with the curious bone defects in the skull and the presence of cholesterol in the ear discharge were suggestive of lipoidosis.

This suggestion was further favoured by the association of polyuria and the gingivitis discovered during investigation ; but the very low blood cholesterol was put forward to us as against such a diagnosis by the biochemist.

Exploration was decided by means of the usual mastoid incision extended upwards and forwards to suit the case, the temporal muscles were exposed on each side. Each was found to overlie a large cavity which when opened was found to be full of brownish thick material containing yellowish granules. The cavity was bounded deeply by the dura-mater. The walls of the cavity contained protuberant granulations of yellowish colour, which were scraped.

No cholesteatoma or pus was seen, in fact the culture of the contents of the cavity was sterile.

A bit of the bone at the edge of one of the defects and another from the muscle at the junction with diseased tissues were removed for histological examination. This was carried out by Professor Sorour Bey who reports :

" The histological picture of sections from the bits of temporal muscle and bone sent is compatible with xanthomatosis of bone which is regarded as an example of the Hand-Schuller-Christian disease."

The following Figs. 3, 4 and 5 are microphotographs of the appearances under the microscope.

Treatment and Progress.

The diseased tissues were thoroughly removed and the cavity was syringed with warm sterile saline solution. The fluid freely passed out of the meatus and so it was decided to rely on the drainage by this route and the wound was completely closed on each side, uninterrupted healing took place and the ear discharge seemed to cease completely by the end of the first week.

One month after the operation, granulations appeared in the depth of the right meatus, later they appeared, too, in the left side. 90 per cent. alcohol packs were used with apparent cure. Granulations have been seen again every now and then but they always responded well to alcohol (90 per cent.).

When the diagnosis was made clear the patient was put on posterior pituitary extract and given a fat free diet. X-ray therapy for the disease was unfortunately refused by the patient.

Air conduction hearing was found to be greatly improved immediately the mastoid bandages were removed, the patient was able to enjoy conversation ; but unfortunately this lasted only four months when the hearing began to deteriorate again until it was completely lost both by air and bone conduction. This seemed to be due to extension of the disease to the labyrinthine structures.

The polyuria was controlled only during the time of administration of pituitary extract.

The patient saw me, thirteen months after the operation, with right sided subtemporal swelling—simulating that of zygomatic mastoiditis and associated with right proptosis. Two months after that, the same condition appeared on the left side. These new swellings used to disappear with great improvement in the proptosis on opening the mastoid wounds and draining the contents.

A. S. Handousa Bey

Comment.

Text books give the impression that the triad of "skull defects, exophthalmos and diabetes insipidus" is essential for the diagnosis of Hand-Schuller-Christian disease. Following up the literature and study of my case show that all of the three components or some of them may be absent; the combination may only be accomplished very late after establishing the diagnosis. In my case, the outstanding feature was "the double ear discharge". The skull defects and the polyuria, although present were only discovered on careful investigation. The patient did not have an idea of any of them or of the scalp swelling over the bone defects. Exophthalmos was a very late manifestation and was developed a long time after the diagnosis was clear.

Again in Hand-Schuller-Christian Disease the cholesterol content of the blood is believed to be commonly but not invariably raised—in my case it was below normal. It was repeatedly done by a competent Biochemist and did not exceed 120 mgms. per 100 c.c. of blood.

The distribution of the skull defects is very rarely found in the temporal bone—in my case it did involve both bones in a symmetrical manner and simulated double mastoiditis.

The presence of cholesterol in the ear discharge seems to me a very important finding and should in the absence of scales make one suspect lipoidosis. When associated with scales, it may be a manifestation of a cholesteatoma.

May I seize this opportunity to thank all my colleagues who have helped me in diagnosing and treating this case; in particular Professor Sorour Bey who made the diagnosis clear by histological examination and Dr. Kassem Abd-el Khalek for his radiological study.

A CASE OF LIPOIDOSIS SIMULATING DOUBLE MASTOIDITIS—
A. S. HANDOOR BEG



FIG. 1



FIG. 2

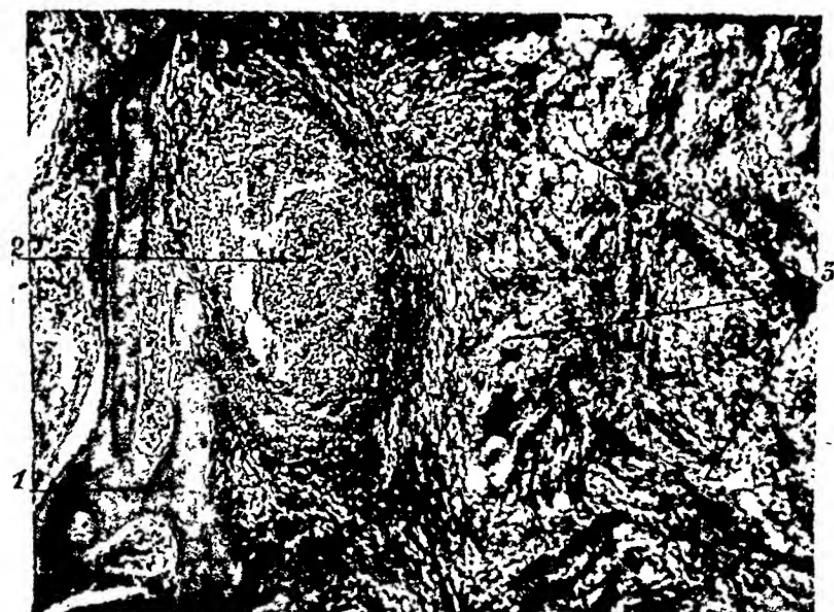


FIG. 3.
XANTHOMA.

1. Bone trabeculae. 2. Lymphoid cells aggregations.
cells. (Xanthoma cells.) 3. Protoplasm vaculated

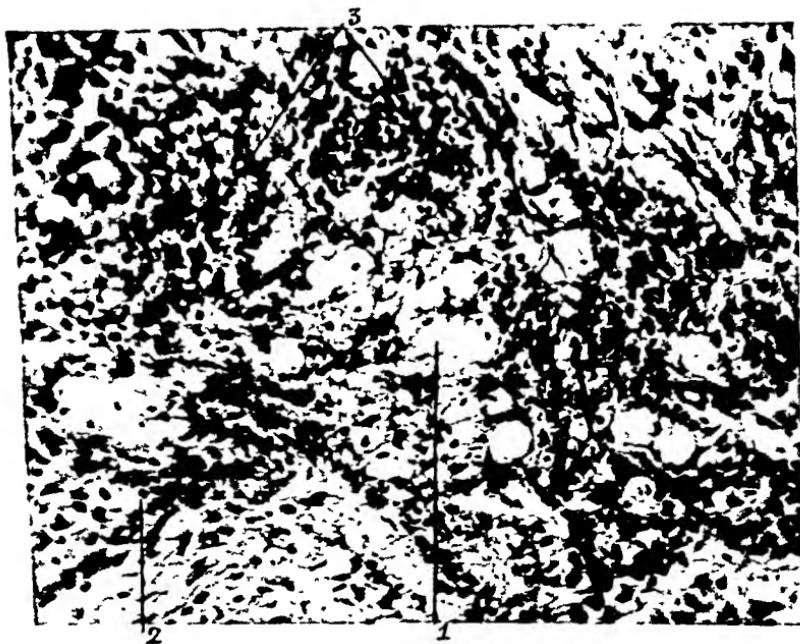


FIG. 4.
XANTHOMA.
1. Xanthoma cells. 2 and 3. Eosinophile cells.

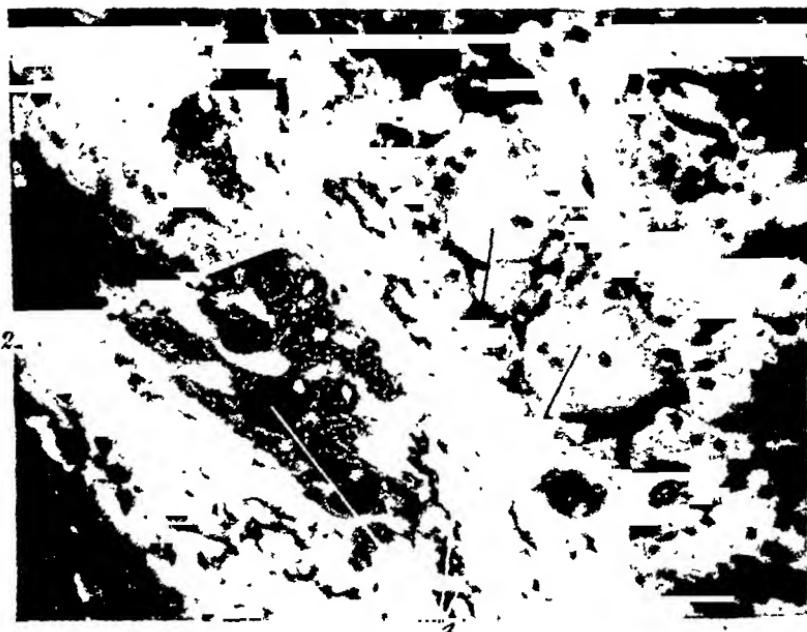


FIG. 5.
XANTHOMA. HIGH POWER.

1. Xanthoma cells. 2. Cellular strands of fibrous tissue infiltrated with eosinophiles.

CLINICAL NOTE

"SIMPLE" ULCERATION OF THE EXTERNAL AUDITORY MEATUS

By W. M. MOLLISON (London)

IN 1939 Mr. Sydney Scott, at a discussion on "Growths of the Ear" mentioned "that curious indolent ulceration of the meatus with exposed bone, which raises the suspicion of malignancy". He recalled one case he had seen with Mr. Cheatle and a number of others: in none had the pathologist found malignancy: he did not think the condition had been described in text-books. I have failed to find any reference to this condition in the text-books not even in Politzer's *Handbuch*; the only reference found was in a paper by Mitchell on *Tumours of the external auditory meatus*; in this he refers to the discussion in 1939; he had seen one case, that of a woman of 43 who had a "furuncle" on the anterior wall which ulcerated but did not discharge: a biopsy revealed no malignancy, and healing took place under local treatment. This indolent ulceration is far from common; I have seen only 10 cases in private patients over a number of years: excluding a boy of 15, the average age of the patients is 56; the oldest was 74, the youngest 42; eight men and two women. Generally the ulceration is confined to one ear but occasionally both are involved, at same time or after some years.

The symptoms are mild; discomfort or slight pain, increased by yawning, or a heavy feeling: a slight discharge or moisture in the ear; an unpleasant smell may be noted: in a few, hearing was diminished and lastly, some noted a tendency to get pimples or boils in the ears.

Examination of the ears showed granulations on the wall of the deep meatus, mostly on the floor, anterior or posterior wall, with slight discharge: with a probe bare bone can be felt in the midst of the ulcerated area; one patient had noticed small granules of bone in the discharge from the ear.

Microscopical examination shows the granulations to be inflammatory. Generally the tympanic membrane is normal, though two patients had a temporary exudative otitis media; while three suffered from deafness, dating back some years before the meatal affection.

Treatment consisted in touching the granulations with caustic, either silver nitrate solution or pure carbolic acid; and the use of drops of argyrol 10 per cent. Healing is slow and even after healing has occurred fresh ulceration is apt to appear. In one case the left ear was first affected in 1927, and remained moist intermittently and ulceration recurred in 1930; four years later the opposite ear developed exactly similar ulceration and it was not till 1936 that both ears were dry.

The only young patient was a boy of 15 referred to me by Mr. Mill; he had had discharge from the left ear for 14 days five months before; now for a

W. M. Mollison

month discharge had recurred ; he had no pain nor deafness. Examination showed granulations on the anterior wall and floor of both deep meatus, with a little purulent discharge ; bare bone was felt with a probe on both sides.

Mr. Mill reported that healing took place after ionization.

It is of some interest that the boy's father and the boy were always "fussing" with their ears.

The absence of continued pain is the important point that distinguishes these "indolent" ulcerations from malignant in the external meatus.

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SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOLOGY

May 7th, 1948

President: DONALD WATSON, F.R.C.S.

Discussion on Lempert Fenestra Nov-Ovalis for the Restoration of Practical Unaided Hearing in Clinical Otosclerosis: Its present status.

MR. TERENCE CAWTHORNE, after congratulating Dr. Lempert on the brilliant presentation of his subject, went on to say that in the fenestration operation Dr. Lempert had done more than any other single person to help the hard of hearing and unlock the door of deafness, but he had done more than this, for not only had he found the key that unlocked the door, but he had given that key to others and taught them how to use it, with the result that there were many men all over the world today who had been trained by Dr. Lempert in the technique which he had shown to them this morning.

When he was in America the speaker had had the good fortune to see Dr. Lempert at work. During the all-too-brief week that he spent at Dr. Lempert's Institute he had learnt a great deal, and he wished Dr. Lempert to know how very much he appreciated all that had been shown to him and all that he had learnt, not only from watching operations, but from observing the care with which Dr. Lempert selected the patients and the infinite personal pains that he took over each case.

The demonstration of specimens in the West Hall of the Royal Society of Medicine illustrating temporal bone surgery enabled the details of the technique to be appreciated by anyone who had the time to study the specimens. He thought that they represented a magnificent achievement, not only on Dr. Lempert's part, but also on the part of Mr. Olofson, the technician, who had come over to England with Dr. Lempert and who played an important part in arranging and mounting the specimens.

The film that they had just seen gave a very fine pictorial record of Dr. Lempert's operation, and the speaker felt that it represented a triumph of technique over the innumerable difficulties that beset cinematography of temporal bone surgery.

In his paper Dr. Lempert spoke with the authority of a vast experience, and the new bone-dust-free technique that he had described would, the speaker felt sure, represent a real advance. It had been most stimulating to hear Dr. Lempert's insistence on the principle that technical measures, no matter how refined, should never be allowed to supplant the clinical examination of the patient as a whole. Everyone realized the importance and value of audiometry but the speaker was glad to hear Dr. Lempert say that nothing must be allowed to supplant the examination of the patient by the otologist who might have to

Societies' Proceedings

The Section was very glad indeed that Dr. Lempert was accompanied by Dr. Kos. Dr. Kos had been doing some very important otological work for the American Air Force during the war, and he came from the University of Iowa, which had always been famed for the part it had played in otology, as it was there that the pure tone audiometer was first developed.

The speaker asked if Dr. Lempert could tell them what was the chance of long-term improvement in hearing that a surgeon well trained in the fenestration technique could conscientiously offer to his patient ; and, secondly, what steps Dr. Lempert would advise to combat the infection that so often persisted in the cavity after a fenestration operation.

Finally, Mr. Cawthorne paid a personal tribute to Dr. Lempert whom he was very proud to call his friend and also his colleague, for they both had the honour of being Fellows of the American Laryngological, Rhinological and Otological Society and also the great honour of being Honorary Members of the American Otological Society.

On behalf of the Section of Otology of the Royal Society of Medicine, Mr. Cawthorne moved a very hearty vote of thanks to Dr. Julius Lempert for coming all this way to give them such a magnificent presentation.

MR. I. SIMSON HALL, in seconding the vote of thanks, also expressed the great pleasure that it was to have listened to what Dr. Lempert had told them that day. An enormous amount of scientific research and clinical observation had gone to the elaboration of this method. All over the United States there were thousands of people today who had the happiness of hearing when previously they could not hear, and this was due, directly or indirectly, to Dr. Lempert's work. He thought that was the thing that must give him the greatest satisfaction.

One of the most important contributions which Dr. Lempert had made to this operation was his demonstration that it was capable of being done safely in one stage.

There was a class of case in which it was very difficult to decide whether or not to advise operation. It was a type of patient who had a reasonably good bone conduction for the speech range but by reason of trauma or of other damage to the cochlea had a sharp drop in hearing at the upper level of speech. In such a border-line case, how did Dr. Lempert assess such a patient ?

THE PRESIDENT, in associating himself with what Mr. Cawthorne and Mr. Simson Hall had said, added that the operation was a great advance in surgery. This world-wide interest in fenestration was an excellent thing for surgery in general, but he hoped surgeons' researches would include the whole structure and function of the temporal bone.

Careful technique meant so much in this operation and some present, young as well as old, might find that they were not so equipped as to be able to do it. In that case they should be big enough to realize their limitations and not try. Others would fail to obtain results in this operation. They should stop for a while, and go to some of the masters to learn just that little bit more.

DR. J. LEMPERT said that perhaps the best way he could answer Mr. Cawthorne's question about results would be as follows : If he were to take 100 patients and examine them and find them most suitable for the operation,

Royal Society of Medicine

if they were the type of patient whose hearing could be restored to the practicable decibel level for the three speech frequencies and higher, he could in this type of case restore practical, serviceable, unaided hearing in about 80 out of the 100. If then he waited two years and examined those 80 successful cases at the end of that time he would find himself left with only 60, the condition having recurred in the other 20. This meant that in 25 per cent. of the cases that were successfully operated on and in which hearing was restored, there was no longer practical hearing after two years. The other 75 per cent. would keep their hearing permanently. Such were the figures which had been obtained up to the present but with advances in technique, especially the new method of bone-dust-free fenestra technique, there might be an improvement. Only time would show whether this new technique resulted in a larger proportion of cases in which permanent hearing was restored.

He wished to say something about the patient who came to the otologist and wanted to have a fenestration operation and was found suitable for such operation. It was always best on finding such a patient to tell him the facts. He should be told that he was a suitable case for operation and what the chances of success were. It should be explained to him that there was an 80 per cent. possibility of restoring his hearing immediately and a 60 per cent. possibility of maintaining his hearing permanently. It should also be explained to the patient that there was perhaps one chance in 100 that the hearing would get worse instead of better in the operated ear following the operation. It should also be explained to him that he might well have vertigo for the first few days, that he would have to stay in bed for five days, remain in hospital for ten days and a week later he should be going about his own affairs.

As far as post-operative infection was concerned, he had tried many things to avoid this. The most satisfactory way of avoiding it was to get rapid healing, and to get rapid healing one had to do some skin grafting. With a good skin graft from the thigh, used immediately on the operating table, one should in three or four weeks have a dry and completely healed cavity. But there were cases which would stay dry for a while and then begin to desquamate and some mild staphylococcal infection would make its appearance. There was nothing he could tell them about that which they did not know already. In one case an excellent result would be obtained with sulphathiazole, but when one began to use it for other cases it did not seem to do the same amount of good. Another thing was a solution of gentian violet, and another was sulphadiazine and plain boric acid. In another case one might follow the bold plan of saying to the patient, "Do nothing, and don't see me again for three months", at the end of which time one may find the cavity completely healed. The worst thing one could use was silver nitrate. Some of these wounds continued to discharge for months or even for years. Others dried up perfectly within a relatively short time. He could only suggest that where one thing did not serve another should be tried.

Mr. Simson Hall had spoken of the border-line case. Dr. Lempert had a very strong feeling about these border-line cases. He would not say that they should not operate on them where there were some secondary nerve changes and there was still sufficient cochlear nerve function reservoir for the 512, 1,024 and 2,048 frequencies to improve their hearing, though not to the practical

Societies' Proceedings

unaided level. However, anybody whose livelihood depended upon their hearing would not be satisfied with such a result. Such a person would still need a hearing-aid. Since an individual with inadequate cochlear nerve function cannot hear efficiently without a hearing-aid following fenestration, then he would suggest that they should keep their hearing-aid and not be operated on at all.

On the other hand, there were people who were economically secure and who refused to wear a hearing-aid for social intercourse and wanted to hear a baby cry or to follow conversation when playing bridge: For them the fenestration operation was justifiable and they could get a good enough result to be satisfied without wearing a hearing-aid. But the fact that they did not wear a hearing-aid should not lead to the supposition that they would not need such an aid to achieve economic and social security if they needed it. Over 80 per cent. of the deafened who came to see him wore hearing-aids but they were averse to using hearing-aids because they did not want to proclaim their infirmity. They did not want a "crutch". If they could get their hearing restored with the fenestration operation, that was what they wanted, even if there was inadequate bone conduction hearing in the high frequencies which would make the restoration of practical hearing doubtful. If they still wanted it even after a full explanation of what could be obtained by means of a hearing-aid and by means of operation respectively, there was no reason why they should be denied the operation. But these people could get only a limited improvement in hearing, which was not practical or serviceable enough for them to continue their life's work without the additional use of a hearing-aid.

ROYAL SOCIETY OF MEDICINE—
SECTION OF OTOTOLOGY WITH SECTION OF LARYNGOLOGY—
COMBINED SUMMER MEETING HELD IN BRISTOL

OTOLOGICAL SESSION

July 3rd, 1948.

Chairman—DONALD WATSON, F.R.C.S.
(President of the Section of Otology)

Ménière's Disease

By A. J. WRIGHT, F.R.C.S.

SUMMARY

FROM the results of a clinical and statistical study of 350 cases of Ménière's disease the following conclusions may be drawn. Acute disease or surgical operation, particularly dental extractions, seem sometimes to be related to the onset of the complaint. Allergy and true migraine do not frequently coexist. Allergy in general is not an important factor. Long duration of the complaint does not seem to be an adverse factor in prognosis but advanced age does. The surgical treatment of infection in nose, mouth or throat does as a whole improve the prognosis as compared with cases not so treated.

Of such surgical treatment dental extractions are found to produce the most favourable results with tonsillectomy a good second; operations on the nasal sinuses, however, do not seem to improve the prognosis but this may be accounted for by their failure adequately to influence the relevant infection.

During the period of fifteen years or so in which I have been interested in Ménière's disease I have accumulated clinical records and carried out a follow-up of some 350 private cases.

This paper gives the results of an analysis of this material in certain particular directions which would seem likely to help in the solution of the problem of the causation of the disease.

The cases studied had been followed up for periods varying from one to ten years with an average of about three years. The investigation has been particularly designed towards arriving at an answer to certain defined questions which might be expected to provide some evidence as to aetiology.

(1) *The reason given by the patient for the onset of the complaint.*—In the very great majority of cases the patient is as mystified as the doctor as to why this distressing disease should have come upon him. Of the 350 cases dealt with, in only 30 was any cause suggested. Of these 30, however, I was surprised to discover that in 15, i.e. no less than half, a recent extraction of teeth was blamed for the onset of the complaint.

Societies' Proceedings

Causes	Number of cases	Causes	Number of cases
Extraction of teeth ..	15	Influenza ..	3
Trauma : Blast of motor horn ..	1	Hysterectomy ..	1
Head injury ..	2	Removal of tonsils ..	1
Syringing ear ..	1	Severe epistaxis ..	1
Acute tonsilitis ..	1	Childbirth ..	1
Pneumonia ..	1	Childbirth with eclampsia ..	2

I feel that this curiously high occurrence of dental extraction as an alleged cause can hardly be regarded as coincidental.

(2) *The co-existence of allergic manifestations.*—In the present analysis only 20 cases (6 per cent.) gave history suggestive of allergy: Asthma, 3; nasal allergy, 10; skin lesions, 5; angioneurotic oedema, 2.

While I have no control figures as to the occurrence of allergy in the general population the figure of 6 per cent. would not seem to be high enough to suggest an aetiological factor of importance.

(3) *Migraine.*—Care is needed in dealing with case-histories since the vertiginous attacks of Ménière's disease are quite frequently diagnosed as migraine both by the medical attendant and the patient. From the present series of 350 cases in only 8 (2 per cent.) was there a history of attacks of a classical migrainous type. In a number of others migraine was mentioned but on investigation it became obvious that the attacks so named had been, in fact, vertiginous and associated with a labyrinthine lesion.

The figure of 2 per cent. for the co-existence of migraine and Ménière's disease in the same individual would not seem to me to suggest any close relationship between the two complaints.

(4) *The duration of the disease or age of the patient as factors in prognosis.*—Length of duration of the disease does not appear to be an adverse factor in prognosis. Thus, while the average duration of the complaint when first seen in the cases later shown as cured or improved was five to six years, in the group of those in which no improvement took place the relative figure was five years. It would seem, therefore, that the duration of the disease is not an important factor in prognosis.

Age of the patient.—Some support would seem to be given from an analysis of this material to the view that the age of the patient is an adverse factor. Thus of the cases aged 50 years or less 65 per cent. were shown as cured or improved while the comparative figure for those over 50 years of age was 45 per cent.

(5) *The importance, or otherwise, of a focus of infection in the aetiology.*—In 1940¹ I presented to this Section a contribution on this question based on a series of cases in which surgical treatment had been carried out for the removal of such a focus from nose, mouth or throat. The results then given seemed to indicate that such treatment favourably influenced the course of the complaint. On the other hand, the period which had elapsed from the time of operation was relatively short and no control figures were then available.

¹ Wright, A. J. (1940) *Proc. R. Soc. Med.*, xxxiii, 459.

Royal Society of Medicine

In my present contribution cases have been followed up, in some cases for as long a period as ten years and in these have been included both those treated on the infective basis and those untreated, so that some comparative figures are available. Cases are grouped in accordance with the surgical treatment adopted and the results are recorded in regard to the symptom of vertigo. In the table "cured" means complete freedom from vertigo, and "improved" means an absence of attacks but with some remaining general unsteadiness.

RESULTS OF SURGICAL TREATMENT OF INFECTION

Form of treatment	Number	Average period of follow up	Cured	Improved	Un-altered	Worse	Cured or improved %
Tonsillectomy ..	32	3.50 yr.	20	1	8	3	66
Dental extraction ..	22	3.00 yr.	16	2	3	1	82
Nasal sinus operation ..	12	2.25 yr.	2	—	7	3	17
Combined operations (more than one of above)	16	3.00 yr.	9	4	2	1	81
Total	82	3.00 yr.	47	7	20	8	66
Untreated cases ..	30	3.00 yr.	2	4	17	7	20

It will be seen that of the 22 cases of dental extractions 16 were cured as far as vertigo is concerned. Of the 32 cases of tonsillectomy, 20 lost their vertigo, but of the 12 cases in which surgical treatment for nasal sinusitis was employed only 2 lost their vertigo. Thus removal of teeth produced the most favourable results, tonsillectomy came next, with nasal sinusitis little better than an also-ran. Figures for those cases in which more than one operative procedure was employed gave results which compared favourably with those of the nasal sinusitis group, but were not as good as the cases of dental extraction and tonsillectomy.

From consideration of the table it would appear that the disease in untreated cases with few exceptions tends to progress, thus of the 30 such cases in only 2 did the vertigo entirely clear up.

A comparison of all cases treated surgically to eradicate infection in mouth, nose or throat with untreated cases as a control shows a figure of 66 per cent. cured or improved in the treated group as compared with 20 per cent. in the untreated.

MR. TERENCE CAWTHORNE said that while focal sepsis might possibly play a part in the causation of certain forms of vertigo he did not think that such cases were frequent. One of the aspects of Mr. Wright's paper that he would like to emphasize was the pathology of this condition. It was well known, thanks to the work of Cairns and Hallpike, that the disorder which they now called Ménière's disease, and which used to be grouped under the umbrella-like term of "Ménière's syndrome" or aural vertigo, had a definitely pathological basis. For this Lindsay and others had suggested the title "hydrops of the labyrinth", as being pathologically descriptive. But there were other forms

Societies' Proceedings

of aural vertigo which were not infrequently confused with Ménière's disease. Since the original observations of Cairns and Hallpike there had been some twenty or more cases in which the temporal bones had been examined post mortem and the symptoms in all these cases were practically identical, namely deafness, tinnitus, and spasmodic bouts of vertigo lasting a relatively short time. These bouts might occur at isolated intervals or in groups. The deafness had always been of the internal ear variety, and together with toxic deafness following quinine it was the only internal ear deafness which appeared to be reversible—a very important point he thought. Another thing about this deafness was the distortion of hearing which had accompanied it. The characteristic of the deafness in Ménière's disease was a dislike of musical sounds or high-pitched sounds. The sufferers disliked music on the wireless, they disliked children's voices, and he had even heard them say that they disliked going to restaurants because of the clatter of knives and forks on plates producing high-pitched sounds. All the cases which he classified as Ménière's disease, including two in which Hallpike and he had had the opportunity of examining the temporal bones, had exhibited these characteristics.

It was known that there were a large number of cases of so-called atypical Ménière's disease—patients with postural dizziness or who had bouts of vertigo but no deafness, and others who had vertigo which lasted for a day or two and which was accentuated when they turned over in bed. There was this fairly large mixed group which in the past had been collected together under the term "Ménière's syndrome", and although it was reasonably certain that the vestibular apparatus was at fault, it was not yet possible to say exactly where the fault lay. He did not think it fair to call them Ménière's disease, because the pathological evidence was lacking.

The main difficulty in obtaining such evidence was that these attacks were never fatal and therefore the otologist never got the pathological material. He hoped that any otologist who had a fatal case of aural vertigo would ensure that the temporal bones and brain stem were made available for investigation. He was sure that the key to the better understanding of aural vertigo was more and still more pathological evidence of the underlying causes.

As to the ætiology of Ménière's disease he agreed with Mr. Wright that patients with Ménière's disease did not suffer more from allergy than did the ordinary run of patients. They had thought in the past that head injury played little or no part in the causation of Ménière's disease—here he was talking of Ménière's disease or hydrops of the labyrinth, and not of other forms of aural vertigo. But he could recall three cases of what he would describe as typical Ménière's disease so far as the symptoms and physical signs were concerned which seemed to be precipitated by a head injury. This was a small number, much too small to permit any conclusion to be drawn and he was just mentioning them because he thought it was worth while making further enquiries into head injury as an ætiological factor.

He had had one interesting case of a patient who presented a typical picture of Ménière's disease following an attack of mumps. The only atypical feature about this was that the patient had an almost complete deafness, but since the attack of mumps she had very typical attacks of giddiness lasting half an hour and going away, coming on again some days or weeks later. The similarity

Royal Society of Medicine

between that condition and hydrops of the labyrinth was so striking that he thought it worth mentioning.

On the question of assessing results, while naturally the vertigo was the important thing, he had found that the hearing was a delicate indicator of the state of affairs within the labyrinth. It was surprising how the hearing did fluctuate with the vertigo, and the hearing was something which could be measured much more easily than the vertigo. Admittedly one could do caloric tests, and the test results of vestibular function did vary, though not so quickly and delicately, he found, as the hearing, and he did think that in measuring the success or otherwise of conservative treatment the audiogram was an extraordinarily useful indicator. It had been to him a source of constant interest and, at first, surprise how the hearing in a case which by all tests was one of internal ear deafness, could vary as much as 40 decibels within a day. They had always thought that internal ear deafness was irreversible, but he knew hardly any other form of deafness which was so subject to variation as the internal ear deafness in Ménière's disease.

DR. GÖSTA DOHLMAN (Lund, Sweden) considered allergy an important factor and cited the case of a young man with severe attacks of vertigo which were abolished by elimination of milk from the diet.

MR. J. ANGELL JAMES said that if a group of cases of aural vertigo were taken they could be placed in two divisions, one in which there was undoubtedly a hydrops of the labyrinth, and the other in which the pathology was uncertain.

The hydrops may be accounted for in two ways, either there may be an increased secretion, or there may be failure of resorption of the endolymph. To his mind the failure of resorption seemed the more probable explanation, and on that possibility Cairns and Hallpike made an interesting point, that in their sections there was a definite fibrosis around the endolymph sac. This seemed an important possibility in preventing the resorption of the endolymph.

With regard to the control of the endolymph pressure it was well known that pressure of the cerebrospinal fluid could be reduced 50 per cent. by severe dehydration, and it seemed rational to think that one could do the same with the endolymph. He had been interested in the matter since 1935, when he heard of Temple Fay's work on the treatment of epilepsy by dehydration, and since then he had used this method in all his Ménière's cases. It also seemed possible that tea was an aetiological factor, as so many patients admitted that they were heavy tea drinkers, and attacks decreased after giving it up. He thought that tea might be a stimulant to endolymph secretion.

The following also took part in the discussion : MR. E. J. GILROY GLASS, MR. W. H. BRADBEER, MR. R. D. OWEN, MR. J. C. HOGG, MR. H. V. FORSTER and MR. E. D. D. DAVIS.

MR. A. J. WRIGHT, in reply, said that Mr. Cawthorne had rather supported the use of the term "hydrops of the labyrinth". He was hoping they would get the name "Ménière's" attached to this group. The material in his paper was selected on the basis of cases which, Mr. Cawthorne would agree with him, they were in the habit of calling Ménière's disease.

A form of injury which he had encountered on one occasion was in the case of a lady who went for a long drive in the winter with the car window open and within a few hours she presented a typical picture of Ménière's disease.

Societies' Proceedings

Mr. Davis had questioned whether one could have Ménière's disease in which there was deafness and afterwards a return to normal. Occasionally one did find such cases. Out of the whole bulk of hospital and private cases he could recall two or three in which there was a considerable defect in hearing and afterwards a complete return to normal, but this was very exceptional.

There was no reason why any lesion of the labyrinth should not produce a somewhat similar type of clinical picture. Mr. Bradbeer had suggested that these cases arose because the function of the labyrinth had worn out in elderly people. But the point which seemed to him to be against that was the fact that this complaint was quite common in young people.

Mr. Owen had asked about middle-ear disease. That was a question they had discussed before. His own view was that it would obviously seem quite likely that inflammatory diseases in the neighbourhood would make the labyrinth itself more likely to become diseased, but from such studies as he had been able to carry out it did not seem likely that middle-ear disease was a causative factor in these cases. He was interested in the suggestion that sometimes the extraction of the teeth would apparently start the disease. He regarded that as evidence in support of the infective hypothesis.

Dr. Dohlman had mentioned milk as causing allergy ; he himself had come across one case in which if the man took pork he got vertiginous attacks.

He suggested as a possible hypothesis for the mechanical explanation of obstructive attacks, alterations in the consistency of the endolymph. One had only to think for a moment of the series of small chambers communicating by extremely narrow passages through which the circulation had to take place, to realize how this might arise.

Mr. Angell James had stressed the suggestion that fundamental interference with resorption was a big factor. Possibly the reason for the attacks was a sudden obstruction in a portion of the labyrinthine circulatory system.

Purulent Pachymeningitis

By SIR HUGH CAIRNS, K.B.E., F.R.C.S., and F. SCHILLER, M.D.

In this paper we report four years' experience of penicillin in the treatment of purulent pachymeningitis. Formerly the condition was almost always fatal, even after the introduction of sulphonamides : since the advent of penicillin 7 of our 15 cases have recovered, and these results should be greatly bettered now that penicillin is freely available and we are beginning to understand the problems of treatment. We have seen 33 cases of this disease in the last twenty years.

It will be best to begin defining purulent pachymeningitis by describing a typical case from the days before penicillin.

This patient was a man of 47 seen by one of us with Mr. F. C. Capps in 1936. He had suffered from chronic pansinusitis for years and had recently developed an infected mucocele of the frontal sinus with a lump on the forehead. Pressure on the lump produced a discharge of pus from the right nostril. Three months later both antra were drained of foul pus by the nasal route (*Str. haemolyticus* and in small numbers *Staph. aureus*), and drainage of the frontal sinuses was established by removing the anterior ends of the middle turbinate bones and

Royal Society of Medicine

external resection of the inner part of the floor of the right frontal sinus. For nine days the patient did well. Then he developed a spreading osteomyelitis of the facial bones with fever, swelling and abscess formation about the eyes and upper jaw, for which further operations were required. His wounds discharged much pus and he became weak, wasted and anæmic.

He was given sensitized streptococcal vaccine, prontosil and blood transfusions, but the facial osteomyelitis continued and, twelve weeks after its onset, spread to the frontal bone. During the next five weeks the osteomyelitis gradually extended backwards and the patient had headaches, facial pain and slight fever, and he became much more irritable.

Purulent pachymeningitis first showed itself on *February 4th, 1937*, about sixteen weeks after the onset of facial osteomyelitis. The patient noticed a weakness and numbness of the right leg, and twelve hours later slight numbness and difficulty of control of the right hand; he vomited twice, had slight headache and fever (100.4° F.).

On examination there was slight hemiparesis and sensory loss in the right upper and lower limbs, more marked in the lower limb. Eighteen hours after the onset of these symptoms the patient began to show slight dysphasia, and right homonymous hemianopia. On the next day, *February 5th*, he had gross aphasia, almost complete right hemiplegia, weakness and sensory disturbance of the left lower limb, incontinence of urine and faeces.

Operation on this day showed gross osteomyelitis of the skull, extending as far back as the parietal region, with subpericranial pus and extradural granulations. On opening the dura thick pus was found in the subdural space and small amounts could be collected for some time by depressing the brain away from the dura. Films of the pus showed streptococci and cultures yielded *Str. viridans*. The patient grew steadily worse and died on *February 9th*.

In previous studies of intracranial spread of infection from the paranasal sinuses and mastoid little attention has been given to the subdural space. In their admirable work Logan Turner and Reynolds (1931) figure the dura as being in immediate contact with the arachnoid. In fact these membranes are separated from one another by a narrow space which usually contains a very small amount of fluid. This space may be occupied by a film of pus of variable thickness: the pus is not circumscribed in the first instance and may spread over part or whole of one or both cerebral hemispheres. This condition is called purulent pachymeningitis. If the condition is not cured at this stage, and the patient continues to survive, the pus becomes loculated by adhesions between dura and arachnoid to form one or more subdural abscesses. It is necessary at this stage to point out that not all subdural abscesses are secondary to purulent pachymeningitis; some, which are localized from the start, are secondary to necrosis of a patch of dura over the mastoid or frontal sinus, or are secondary to an abscess in the superficial part of the brain. We are not proposing to discuss these types of subdural abscess here.

In the early literature there was some confusion about the situation of subdural pus. Some cases of what was obviously purulent pachymeningitis were described as leptomenitis. These two conditions, it must be emphasized, are quite distinct. The subdural space is quite distinct from the subarachnoid space; it is a single continuous space over the surface of the

Societies' Proceedings

brain and spinal cord, except where it is crossed by blood-vessels and nerves, or where arachnoid granulations are embedded in the dura. Air passes readily from one end of the cranial subdural space to the other. Penicillin, as we have shown, passes readily to and fro between the blood-stream and any fluids which may accumulate in the subdural space.

The subarachnoid space, on the other hand, is a channel traversed by numerous fine septa and containing cerebrospinal fluid. Air in it cannot move freely with alterations of head posture, and penicillin does not pass freely between the blood and C.S.F.

In purulent leptomeningitis there are many cells in the C.S.F., and there are neck rigidity and the other signs of meningism. In purulent pachymeningitis there are few cells in the C.S.F. and little or no neck rigidity, unless and until the condition becomes complicated by leptomeningitis; the symptoms are those of a rapidly progressive paralysis of one or both cerebral hemispheres—hemiplegia, homonymous hemianopia, sensory loss in the paralysed limbs and, if the dominant hemisphere is involved, aphasia. Fits may occur in the early stages of this cortical paralysis. The temperature is usually higher than in leptomeningitis, probably because of the absorptive properties of the subdural space.

CAUSE

Purulent pachymeningitis is usually secondary to spreading osteomyelitis of the skull which is an unhappy sequel in some cases of pansinusitis. In our 33 cases the primary infection was in the paranasal sinuses in 23 cases, in the petrous bone in 6 cases, while in 4 cases the infection was from a distant focus. According to Turner and Reynolds (1931) the condition arises most commonly in chronic pansinusitis after some operative interference, sometimes no more than simple puncture of the maxillary sinus. As Dan McKenzie (1913) said: "What seems to be an irreproachable operation is followed by progressive osteomyelitis." The condition is clearly an uncommon one, but it has always made a deep impression because of the rapid intracranial spread of the infection and the almost uniformly fatal issue. One of the older otologists, describing the rapid spread of infection after some relatively simple and well-executed operation, said it was like setting fire to shavings.

ASSOCIATED LESIONS

We have described the pathology of this condition elsewhere (Schiller, Russell and Cairns, 1948) and it is only necessary here to mention the lesions which are associated with purulent pachymeningitis.

Spreading osteomyelitis of the skull was present in 26 of our 33 cases—in at least 26 cases for, as Dan McKenzie observed, the osteomyelitis may be overlooked. We have had a case in which at necropsy the skull vault was passed as normal by the pathologist, though at operation we had found beads of pus in the parietal diploe. Now that we have an effective antibiotic for this condition it is even more likely that spreading osteomyelitis will be overlooked unless the skull is repeatedly examined radiologically.

The osteomyelitis usually produces oedema and great venous engorgement of the overlying scalp; at operation the pericranium strips very easily and the exposed bone exudes blood from many points.

Royal Society of Medicine

Thrombosis of the large dural sinuses or cerebral veins was present in 8 of our 33 cases, but Kubik and Adams (1943) found a higher incidence.

Multiple small cerebral infarcts have been found in some cases at necropsy. Loculated subdural abscess and cerebral abscess have become relatively common since we have been using penicillin and more will be said of these conditions later.

Leptomeningitis was a common sequel before the days of penicillin; also ventriculitis, when needling of the brain for abscess assisted the passage of infection into the ventricles. But these conditions have now become uncommon.

Lung abscess and purulent bronchopneumonia were seen in our series, and in this connection it must be noted that Williams (1944) of the Mayo Clinic has described a group of cases of pansinusitis accompanied by bronchiectasis. Some of our cases may have had suppurative lung lesions before they ever got subdural infection.

DIAGNOSIS

The multiplicity of intracranial infective lesions which are possible in any one case indicate the difficulties of diagnosis. However, the clinical picture of purulent pachymeningitis is sharply defined and although it bears some resemblance to uncomplicated cerebral thrombophlebitis it should usually be fairly easy to recognize. Cerebral thrombophlebitis as the sole cause of intracranial symptoms in cases of pansinusitis and spreading osteomyelitis must be very rare, if our experience is any guide. In cases of doubt there should be no hesitation in opening the dura to inspect the subdural space; and this can if necessary be done through an infected field—through an extradural abscess, for example—now that the infection can be controlled by penicillin.

BACTERIOLOGY

The predominant causal organisms of our series were streptococci of anaerobic, or viridans, or non-haemolytic forms (Schiller, Russell and Cairns, 1948). Staphylococcus and B-haemolytic streptococcus were rare: although the pus from the sinuses usually contained these organisms, the pus from the skull vault and from the subdural space usually contained streptococci of the non-B-haemolytic groups. These organisms may be difficult to culture, and their bacteriological classification is still very ill-defined. They are for the most part sensitive to penicillin: all the cases which we have treated adequately with penicillin have given a good clinical response, and in 3 of 4 cases where the *in vitro* sensitivity was tested the organism was completely inhibited by 0.04 unit-c.c. penicillin or less. However, in one other case the organism was completely insensitive *in vitro* at the usual dilutions; there was some inhibition by 20 U-c.c. but none by 5 U-c.c. The *in vivo* sensitivity of the organism to penicillin could not be tested, owing to shortage of penicillin.

The occurrence of such relatively insensitive organisms indicates that in all these cases the sensitivity of the organism to antibiotics should be tested, and that until the results of the tests are available exceptionally large doses of penicillin should be given.

Societies' Proceedings

EXPERIENCE SINCE THE INTRODUCTION OF PENICILLIN

Since penicillin became available we have had 15 cases of purulent pachymeningitis. Five were incompletely treated owing to shortage of supplies, and, though the infection was modified, all died. Ten have been adequately treated and all but three have recovered.

The methods of treatment.—Systemic penicillin is given in doses of 100,000 units three-hourly, at least until the *in vitro* sensitivity of the organism has been tested. If the organism is normally sensitive the dose may be halved. As bone infection is notoriously prone to relapse, and as there is considerable risk of loculated subdural abscess, systemic penicillin should be continued for at least eight weeks.

It is usually impossible to drain the subdural space. When we tried to do it in the old days the brain plugged the holes in the dura (intracranial pressure is often very high in this disease). We no longer attempt subdural drainage and instead pass one or more rubber catheters into the subdural space through burr-holes. Through each catheter large quantities of dilute penicillin are instilled at frequent intervals—6 c.c. of a solution containing 500 U.c.c., or as much as the subdural space will comfortably hold. Most of this solution is evidently absorbed from the subdural space, for very little of it drains away through the catheter. The solution destroys bacteria, dilutes the pus, tends to prevent loculation and probably has the effect of producing a very high level of penicillin in the blood-vessels of the overlying skull, for some of the venous return from the subdural space passes through the skull bones.

We have not always succeeded in preventing loculation of the pus with formation of a subdural abscess, especially on the medial surface of the hemisphere, and at present we are not sure whether a catheter should be invariably passed along the medial surface of the hemisphere, and whether penicillin should also be instilled into the subdural space of an apparently healthy cerebral hemisphere. Further experience is required on these points. Our present belief is that the more the subdural space can be irrigated the less the risk of loculation.

Subarachnoid and ventricular penicillin is injected as required whenever leptomeningitis is considerable, or there is risk of ventricular contamination, and in the usual doses (10,000 to 15,000 units once or twice daily).

With systemic penicillin in full doses it seems unlikely that there will be need to remove large areas of skull on account of osteomyelitis. It should rarely be necessary to undertake massive removal of the skull vault in the acute stage, as used to be done. These mutilating and bloody operations are ill-supported by a patient who already has purulent pachymeningitis, and in our experience they rarely remove all the infected bone. In the later stages, however, it is important to remove any focus of sequestration and suppuration which remains, for, quite apart from the discomfort of discharging sinuses, these foci are apt to produce a recrudescence of intracranial infection once penicillin is stopped. It is well to note that osteomyelitis of the skull treated by penicillin produces novel radiological appearances and not every area of osteomyelitic rarefaction requires surgical removal.

Royal Society of Medicine

VARIETIES OF RESPONSE TO TREATMENT

The methods described have been evolved gradually, and there is reason to hope that future cases will be more successfully treated than the present series. Only 2 of our 10 fully treated cases have run an uncomplicated course under treatment. The remainder have developed a loculated subdural abscess and two of them have also had an intracerebral abscess. Sample cases will now be described.

An uncomplicated case.—A soldier of 28 who had suffered for years from bad dental sepsis developed pansinusitis and bronchopneumonia. After a fortnight his antra were washed out and next day he developed acute spreading osteomyelitis of the skull and purulent pachymeningitis (*Str. viridans*). When he came under our care on the following day he had right hemiplegia and had lost all speech. He was treated with penicillin intramuscularly (2.5 MU) and subdurally (0.15 MU for fourteen days through a catheter) and also had a few subarachnoid injections. The neurological signs disappeared almost completely; the osteomyelitis of the skull also recovered completely with discharge of pus and spicules of bone from the site of one of the burr-holes. During convalescence he developed signs of consolidation in his right lung but this also recovered. This patient was treated in April 1943. He was probably the first patient with this disease to be treated with penicillin. In the ensuing five years he has had several focal fits affecting the right limbs, but has been otherwise well and has been in regular work.

Purulent pachymeningitis followed by loculated subdural abscess.—A boy of 11 developed right maxillary sinusitis after toothache in April 1944. In July for the first time he became generally ill and a painful swelling appeared on the right side of his forehead. His maxillary antrum was washed out, and next day he became unconscious and showed right hemiplegia. He was observed to have focal motor attacks on the right side. Burr-holes were made and pus was found in the subdural space in the left frontal region; cultures yielded anaerobic streptococci. He was treated with penicillin, as in the previous case, also with sulphadiazine, for at one stage early in the illness he had severe leptomeningitis as well. After preliminary improvement he deteriorated in the fourth week of treatment and a further operation showed a loculated subdural abscess on the medial surface of the left cerebral hemisphere. This was drained. The boy was desperately ill for nearly two weeks, then he made a slow and complete recovery.

Eight months later, as his nose was still discharging, Mr. G. H. Livingstone performed a Caldwell-Luc antrostomy and removed nasal polypi and the anterior part of the middle turbinate bones. Three years later the boy was well and had no residual signs apart from an incomplete right lower homonymous hemianopia.

The onset of loculated subdural abscess may be suspected in these cases when the hemiplegia fails to recover, or when after a slight degree of recovery there is retrogression. The lumbar puncture pressure also rises. The common site for the abscess is between the medial and inferior surfaces of the hemisphere on one side and the falx and tentorium on the other. The pus is found by needling through the intact brain and it can only be distinguished with

Societies' Proceedings

certainty from an intracerebral abscess or pyocephalus by thorotrust pyrography. The characteristic appearance is that the medial and inferior walls of the abscess shadow correspond to the falk and tentorium.

In 2 cases a subdural loculation was not recognized because its development had been masked by continuing penicillin treatment, and the patient subsequently developed a cerebral abscess. We consider it important to establish by means of ventriculography that patients with purulent pachymeningitis have no form of intracranial abscess before their penicillin is stopped and they are allowed to leave hospital.

General management.—These patients may be extremely ill for three to four weeks. Stupor may interfere with swallowing, so that the risk of aspirating fluids into the trachea and bronchi is considerable. For this reason we usually nurse our patients with the head low, by means of low blocks to the foot of the bed; they are usually fed for several days by indwelling stomach tube. Blood transfusions are valuable in the acute stage of the infection. A careful day-to-day clinical assessment and frequent examination of the pressure and cellular content of the lumbar C.S.F. are required in order to detect the onset of subdural loculation and other complications.

The primary focus.—Whenever a primary focus persists after the acute symptoms have subsided we believe that it should be dealt with radically. If possible this operative treatment should be deferred for some months and penicillin should be given systemically for a few days before and after operation.

Prophylaxis.—It seems likely that the incidence of purulent pachymeningitis, uncommon though it may be, could be further reduced with adequate prophylaxis with systemic penicillin, since a considerable proportion of the cases follow operations on the paranasal sinuses and petrous bones. Should penicillin be given before all such operations, or is it possible to foretell the cases in which such complications may arise?

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MR. H. V. FORSTER desired to say a few words about prophylaxis. He would like members to tell if they had had experience of that rare complication osteomyelitis of the upper maxilla. It might follow quite conservative intra-nasal operations done to relieve chronic pansinusitis and which would include an intranasal antrostomy beneath the inferior turbinate.

He had seen very few examples of this complication, but the issue was fatal with eventual spread to the meninges, and in spite of post-operative treatment with the sulpha group of drugs in days before the discovery of penicillin. He could not account for the spread of this disease of the bone,

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except that one had sensed the poor general condition of the patient. One observed its slow advance upwards along the ascending nasal process and across the hard palate.

The surgeon would naturally dread the performance of extensive operations upon the bones of the face, though perhaps hope of recovery had rested with such drastic measures.

Ought we to use systemic penicillin treatment more often before and after operating intranasally on chronic cases of suppurative accessory sinus disease?

He had mentioned this complication in an earlier discussion at one of our meetings (December 5th, 1947, see *J. Laryng. and Otol.*), and had had helpful replies from the opener and from members taking part.

MR. A. M. ROSS asked whether in operations when there was sinus infection the authors could specify whether it was the frontal or the maxillary or ethmoid sinus which was concerned. Was it one particular sinus or all the sinuses?

MR. F. C. W. CAPPS said that he was unaware when he came to listen to this paper that the rather tragic case mentioned, and with which he had been intimately concerned, was going to form the basis of the discussion. That case was very fresh in his memory. It was a disastrous affair, and it was made the more disastrous in that the chronic sinusitis and the infected mucocele were found only in the course of a general examination of the upper respiratory tract. The man actually came for trouble in the external auditory meatus, and was persuaded that treatment was needed for the sinus disease.

He had had at least two other cases, one of which fairly recently had had a very happy sequel, thanks to the co-operation of a neurosurgical colleague, Mr. J. E. A. O'Connell. It was a relief to have now this penicillin regime, which could at least avert any trouble in a high proportion of cases. The question was whether in every simple intranasal operation on the antrum or ethmoid or other sinus they were to give prophylactic penicillin. It would seem at first sight an obvious thing to do, but penicillin had its disadvantages as well as its blessings. All those who had had experience of it would be prepared to say that it was a very unpleasant thing to have an allergic reaction in the case of perhaps essential second course of penicillin after a very thorough first course had been given. Would Dr. Schiller consider it adequate if they waited for the first sign of something going wrong before attacking the case with prophylactic measures? In a high proportion of cases they would still have their penicillin in reserve and it might happen at a later date that it could be given without the unpleasant sequelae which sometimes attended a second course of penicillin.

DR. SCHILLER had mentioned cases of thrombophlebitis as somewhat rare. He had certainly had two cases, both of which survived. The earlier was one in which he held his hand very considerably, as was now advised. It was the case of a girl who came in with an obvious orbital swelling, having had a sinus infection, and all that was done was to drain the peri-orbital tissues. She had a severe series of fits and the condition did rather suggest that it was not an ordinary case of meningitis. She recovered satisfactorily. This was before the days of sulphonamide or penicillin. At a later date he removed a deep sequestrum of the inner frontal crest from this patient. She had had a thrombophlebitis of the sinus with a spread of the phlebitis over the cortical area.

Societies' Proceedings

Another case was a child who was extremely ill with septicæmia and a hemiplegia. She had had a transient swelling over one eye. In that case he called in his neurological colleague, Dr. D. E. Denny-Brown, who thought it might be a thrombophlebitis and advised exploring widely the frontal area. This was done and a small, narrow, frontal sinus was found with a little bead of pus lying over the sinus. That child made an uninterrupted recovery. Thus of these two cases the one recovered as a result of masterly inactivity and the other as the result of an extensive operation. It was to be hoped that these extensive removals in osteomyelitis cases were now at an end.

MR. R. L. FLETT said that he had seen osteomyelitis follow operation on the maxilla, but all the cases he had seen had been associated with polypi in the ethmoids or antra, with thick pus coming from the sinuses ; and he thought that any case like that with cellulitis over the frontal bone should have injections of penicillin before surgery was undertaken. In this type of case penicillin was absolutely essential.

MR. NORMAN PATTERSON said that he could recall only one case of osteomyelitis following operation on the frontal sinus, but he could remember three following operations on the antrum. One of these was a case on whom an operation on the other antrum had been done ten years previously without any complication. He was called in to see her because there was a slight swelling over the side of the nose. Large areas of bone were removed. In another case haemorrhage developed after intranasal antrostomy. The patient's nose was packed for about forty-eight hours ; he soon afterwards developed osteomyelitis. The third case was one the late Mr. Herbert Tilley asked him to see. All three patients died. The other case following frontal sinus operation recovered after the removal of nearly the whole of the frontal bone.

MR. E. D. D. DAVIS was of the opinion that in cases where the possibility of an osteomyelitis was expected a course of systemic penicillin should be given. If extensive bone operation was to be done a course of penicillin should be undertaken before as well as after the operation. The earliest possible diagnosis of meningitis is of the greatest importance. Meningitis arising from the ear may be expected in certain cases. Children and young adults are more susceptible to meningitis particularly in cases of otitis media following scarlet fever and measles. The acute streptococcal mastoid of sudden rapid onset in children was recognized by a profuse discharge of serous fluid from the ear, and when the mastoid was opened, the cells were full of turbid serum : an osteomyelitis without localization.

Suppuration of the retrofacial mastoid air cells calls for a careful watch for threatened meningitis. A persistent headache with a slight rise of temperature and later vomiting is an indication of meningitis. An early diagnosis of meningitis cannot be made without an examination of the cerebrospinal fluid. Rigidity of the neck is a late sign and on two occasions he had seen a stiff neck resulting from acute adenitis of the glands of the neck. Both cases had been diagnosed as a meningo-encephalitis but they recovered in a few days. He examined the notes of 27 cases of meningitis with rigidity of the neck and only 4 recovered and these 4 were treated by large doses of penicillin and sulphadiazine. He believed the earlier the diagnosis and the more prompt treatment with penicillin and sulphadiazine the better the result.

Royal Society of Medicine

THE CHAIRMAN (Mr. Donald Watson), after saying how much the Section appreciated the paper, said that he had seen several cases of osteomyelitis in the frontal sinus cured practically without operation since the advent of penicillin. All the intervention that took place was the simple removal of pus. His own practice—he was thinking particularly of cases of polypi which had an underlying osteitis—was to use penicillin for twenty-four hours before operation and twenty-four hours afterwards. Thus one operated, so to speak, in a bath of penicillin and in that way infection was stayed. It was not necessary to give a long course of penicillin.

DR. F. SCHILLER, in reply to the question as to whether it could be told which sinus was involved—the infection related to practically all the sinuses, and it was very difficult to single out one in particular. Certainly antral infection played a great part.

He wondered how important the problem of allergy and acquired resistance to penicillin really was, considering the life-saving properties of the drug.

GENERAL NOTES

MEETINGS.

THE ROYAL INFIRMARY, EDINBURGH.

February 12th, 1949. 2.15 p.m. Film, "The Fenestration Operation", by Dr. Julius Lempert. 3.30 p.m. Tea. 4 p.m. Business Meeting. Discussion on the National Health Service as it affects otolaryngological practice.

THE ROYAL SOCIETY OF MEDICINE.

1 Wimpole Street, London, W.1.

Section of Laryngology. March 4th, 1949, at 2.30 p.m. Mr. C. P. Wilson and Mr. P. Franklin: "Indications for and results of resection of the Oesophagus for Carcinoma."

Section of Otology. March 4th, 1949, at 10.30 a.m. Mr. C. S. Hallpike and Mr. R. R. Simpson: "Nerve deafness."

BRITISH ASSOCIATION OF OTOLARYNGOLOGISTS.

March 4th, 1949, at 5.30 p.m. Council Meeting. Dinner at 7 for 7.30 p.m.

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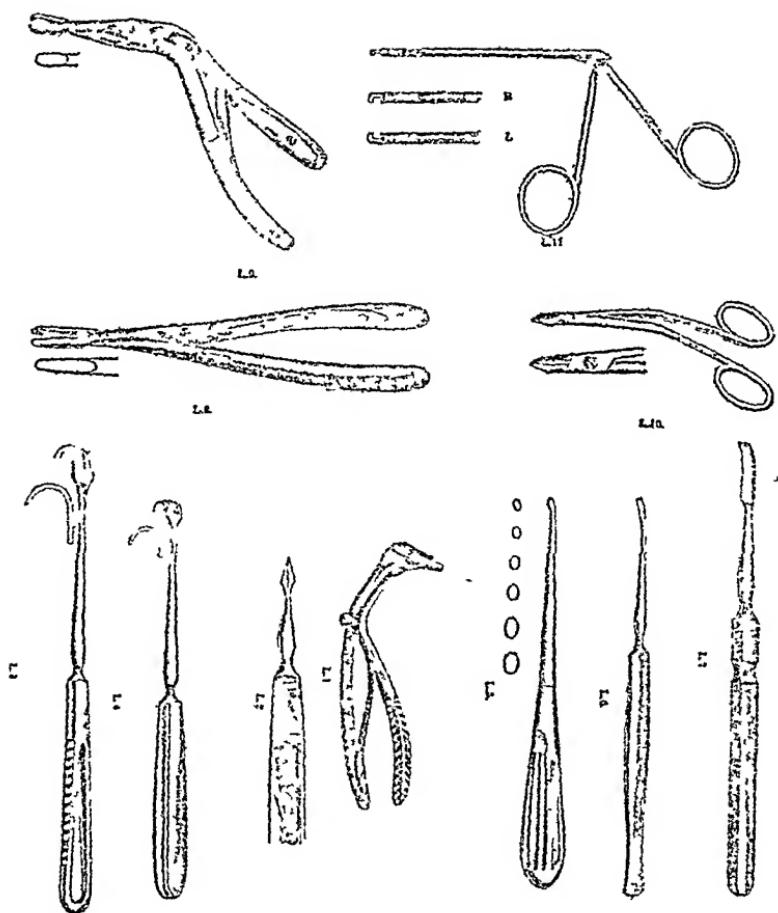
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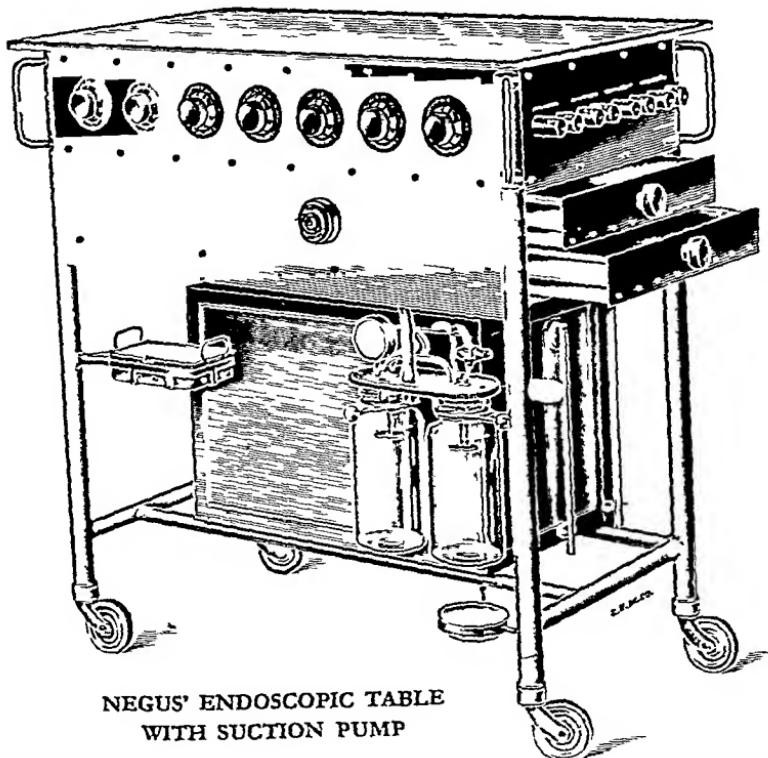
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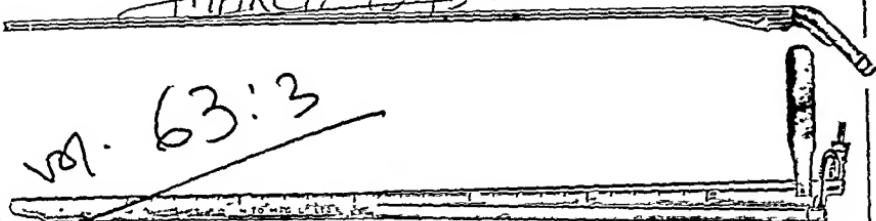
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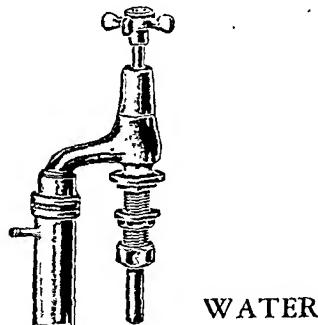
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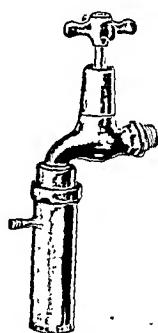
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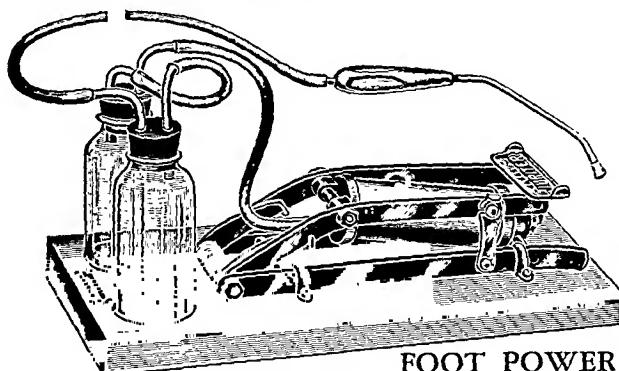


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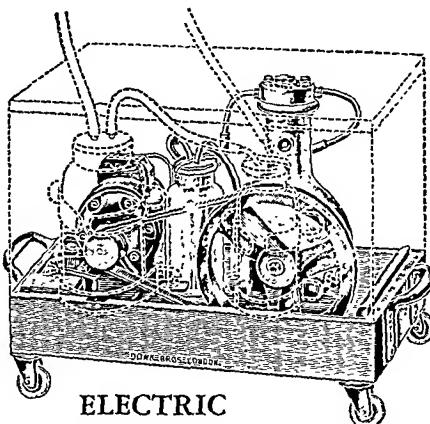
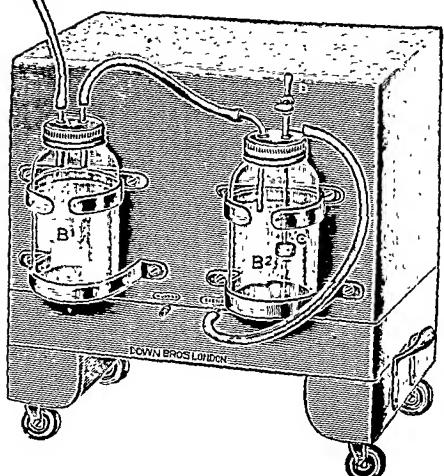


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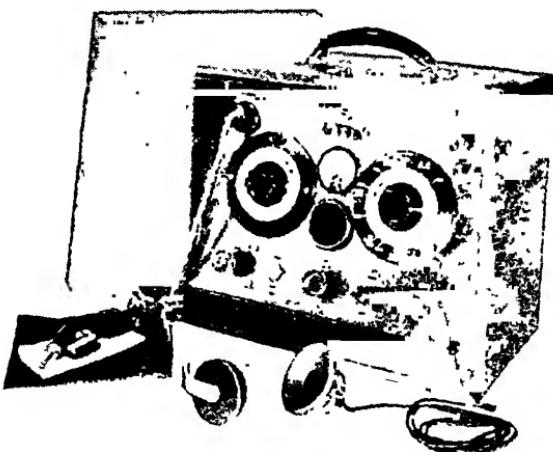
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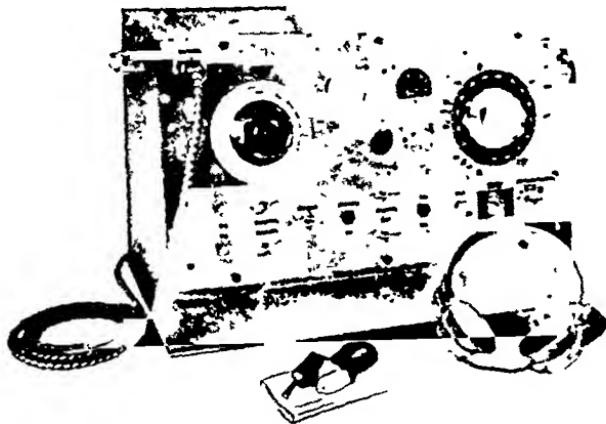
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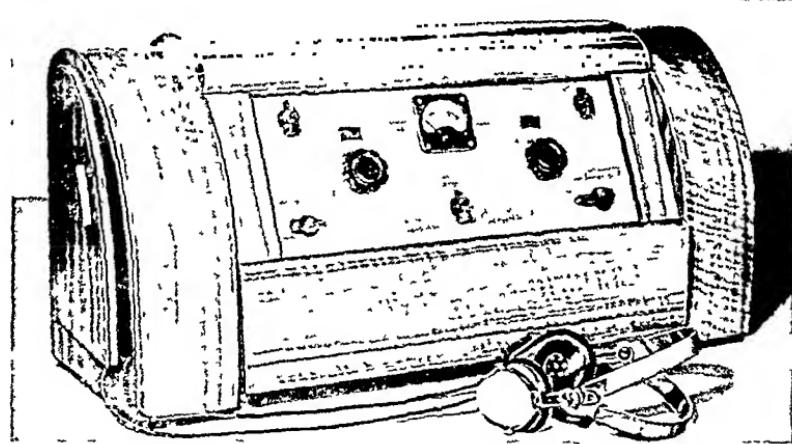
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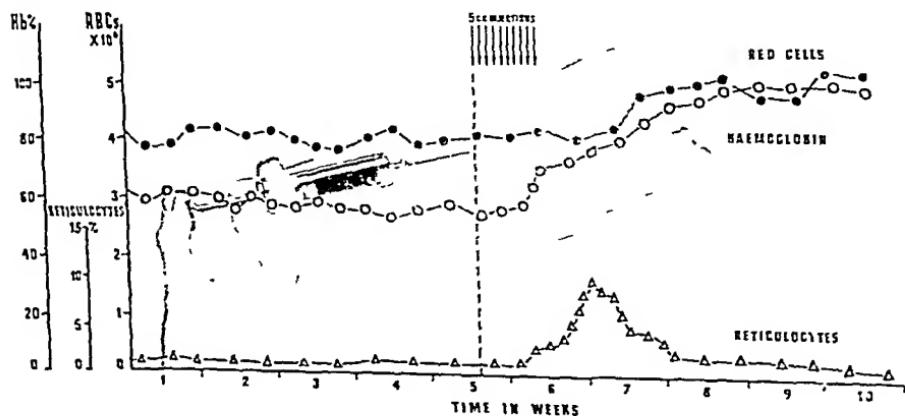
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CONTENTS

	PAGE
THE END OF AN ERA. Walter Howarth (London)	107
SEPTICÆMIA AFTER TONSIL OPERATIONS. E. Watson Williams (Bristol)	115
ON THE EVOLUTION OF THE AUDITORY CONDUCTING APPARATUS—I. A. Tumarkin (Liverpool)	119
SOME OBSERVATIONS ON ANTRO-CHOANAL POLYPUS. A. R. Dingley (London)	141
THE CLINICAL ASPECT OF PERCEPTIVE DEAFNESS—SO-CALLED NERVE OR INTERNAL EAR DEAFNESS. E. D. D. Davis (London)	144
CLINICAL RECORD—	
Associated Oesophageal and Gastric Strictures following Swallowing of Caustic Soda. G. H. Caiger (Durban)	154
SOCIETIES' PROCEEDINGS—	
Royal Society of Medicine—Section of Laryngology with Section of Otology	159
ABSTRACTS—	
Ear	170
Present Methods for Testing Auditory Function Marvin F. Jones, Problems of Diagnosis in Obstruction of the Eustachian Tube. Frederick T. Hill, Psychogenic Deafness. W. G. Hardy.	
Nose	171
A New Method of Treating Angiomatous Growths of the Nose. E. Urbantschitsch.	
Larynx	171
Streptomycin in Tuberculous laryngitis P. Milot.	
Oesophagus	172
Carcinoma of the Oesophagus Richard H. Sweet.	
Miscellaneous	172
Streptomycin. Geoffrey Marshall, et. al.; Cancer Research R. R. Spencer; Identification of Malignant Tissue Henry S. Greene; The Volume of the Bronchial Tree at Various Levels and its Possible Physiological Significance A. C. Hilding and David Hilding; Novocaine as a Therapeutic Agent in Oto rhinolaryngology. N. Hibler; Neuron Arcs of Clinical Significance in Laryngology A. C. Furstenberg and Elizabeth Crosby.	
OBITUARY—	
Mr. Lionel Colledge	176

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March 1949

THE END OF AN ERA* A RETROSPECT AND A PROSPECT

By WALTER HOWARTH (London)

WE are so much preoccupied nowadays with the problems of the present and the future, that our debt to the past is sometimes apt to be overlooked. We are, in fact, inclined to take our present state of knowledge for granted, and when we think of the generations which have preceded our own we are apt to do so with a sense of superiority, and of pity for their mistakes, rather than with a sense of humility, and of admiration for their achievements.

But the knowledge we now accept so easily was not acquired all of one piece, but painfully, laboriously, step by step, just as painfully, laboriously and step by step we ourselves are groping towards a brighter light.

At the beginning of a new academic year we naturally look to the future and wonder what, for good or ill, it may hold for us; but I think we shall take better stock of our position if we consider first how that position was established.

During the latter period of the recent war there passed from our midst the remaining members of a group of men who may be said to have laid the foundations of Laryngology and Otology in England, or, if this is thought to be too bold a statement—for there were brave men before Agamemnon—they at least reared a very considerable edifice of solid and durable masonry.

As the passing of this group is, to some extent, the end of an era, I who am among the more elderly of their successors think that it might be well to call to your mind some of their achievements. It would not

* The Annual address given at the Royal National Throat and Ear Hospital and Institute of Laryngology, November, 1948.

Walter Howarth

of course be possible to relate anything like all the striking advances that were made, or to mention by name all those who made them or the many difficulties that had to be overcome in their pursuit of special knowledge, but it will I think be helpful to call to mind a few examples.

At the present time, Otosclerosis is a subject that looms very large in the literature and in the thoughts of otologists.

Some thirty years ago ALBERT GRAY of Glasgow, after meditating on this obscure disease for many years, decided to go and find out all that was known about it. He visited, as was then the custom, all the well-known clinics on the Continent, and found to his dismay that practically nothing was known about it. On returning to England he may be said to have devoted his life to the study of this disease.

He was one of the first to apply modern methods to the study of the temporal bone in otosclerosis, and his researches into the structure of the temporal bones of various animals resulted in the many beautiful specimens with which you are doubtless familiar, as they are illustrated in his monumental work. His experiments with amylnitrite and the striking results obtained from its inhalation led him to believe that in many cases the deafness of otosclerosis was largely the result of functional and not structural defect in the organ of hearing. The rapidity of the improvement and its equally rapid disappearance suggest that it is brought about by the sudden increase of fresh blood to the cochlea. This can only take place through the action of the vasomotor reflex system—hence his contention that the essential causative factor in otosclerosis is a slowly progressive failure in the function of the vasomotor reflex of the organ of hearing as a whole. This would, over a period of time, suffice to bring about those pathological changes in the bone and in the neurilemma of the cochlear nerve that Gray could demonstrate as being associated with this disease, and he came to the conclusion that the clinical picture of otosclerosis is produced for the most part by the degeneration of the cochlear nerve and only in a minor degree by the fixation of the stapes; and he postulated some common factor in the degenerative changes that take place in the bone and in the nerve. The stimulus of Gray's research opened up a vast series of enquiries, and the end is not yet. All our attention at the present time would seem to be centred on the stapes factor and the fenestration operation; is it not perhaps time that we turned our attention once more to the underlying cause?

About this time there was rising into eminence, also in Glasgow, another acute and careful observer, ADAM BROWN KELLY. His interests were clinical, and it is to his insight that we owe the explanation of several obscure conditions.

He was the first to describe a condition in which there is dryness and glazing of the mucous membrane of the pharynx and upper part of the

The End of an Era

œsophagus, sometimes associated with superficial ulceration and the formation of granulation tissue. This is apt to occur in elderly women and may cause dysphagia. In some cases there is a concomitant glossitis of streptococcal type and also a secondary anaemia with achlorhydria.

At the very same meeting at which Brown Kelly's paper was read, DONALD PATERSON of Cardiff—also a skilled œsophagoscopist—read a paper in which he described a similar condition that he had observed in patients under his care. Kelly's paper was entitled "Spasm at the Entrance to the Oesophagus", and Paterson's "A Clinical Type of Dysphagia".

This combination of chronic inflammation in the œsophagus and tongue, associated with anaemia, is often referred to as the Plummer-Vinson syndrome, after two American observers—but it was first described by Brown Kelly and Paterson and should rightly go by their names.

Brown Kelly was also a pioneer in the elucidation of some cases of dysphagia that had remained unexplained. These he proved to be due to congenital shortening of the œsophagus with thoracic stomach. In these cases the œsophagus is usually shortened at the level of the 7th thoracic vertebra, and there may be a stricture at this point. Below this there is often a dilatation which consists partly of stomach, as may be recognized by the character of the mucous membrane as seen through the œsophagoscope or on the post-mortem table. Needless to say, the discovery aroused the utmost interest and enabled many other observers to confirm it in succeeding years and to establish it as a definite clinical entity.

Brown Kelly also investigated and described congenital abnormalities at or near the upper end of the œsophagus.

Incidentally, Brown Kelly was one of the pioneers of œsophagoscopy in this country, and took endless trouble to perfect his technique. It should be remembered that in those days the lighting system of endoscopes was not nearly as perfect as it is now.

The sister school of Edinburgh was not to be outdone, and had in LOGAN TURNER, the most eminent member of that school founded by MacBride, a most painstaking and scientific observer who made many striking and original contributions to Rhinology and Laryngology. His papers on mucocele of the nasal accessory sinuses afford one of the earliest explanations of this condition, and, whilst engaged on a study of the intracranial complications of sinus suppuration, he mapped out the paths of infection to the cranial cavity, showing that the spread was mainly along venous channels either by a septic embolus, a septic thrombus, or by direct extension of organisms. Logan Turner was, I think, the first to point out the occurrence of vocal cord paralysis in carcinoma of the breast and to show that the explanation was due to the

Walter Howarth

enlargement of the retro-oesophageal lymphatic glands with pressure on the recurrent nerve. He also provided a convincing explanation in cases where the palsy was contralateral, by showing the paths of lymphatic spread. He also mapped out the anatomical distribution and variation of the mastoid cellular system, basing his conclusions on the examination of more than a thousand skulls representing many races of mankind.

Not only was he a great clinician and investigator, but he was also a man of wide, and one might say prophetic, vision. In his Semon Lecture of 1923, a quarter of a century ago, he said : "Finally, may we not visualize an Institute of Laryngology and Otology, on the lines created by the Rockefeller Foundation, erected in some convenient centre and linked with all our clinical departments, where the coming generation of young specialists and teachers would extend their education, receive postgraduate instruction, and at the same time play their part in the advancement of the specialty." He did not, alas ! live to see his vision come true—but how he would have welcomed it !

WILLIAM MILLIGAN, of Manchester, was an outstanding aural surgeon and one of the earliest authorities on septic sinus thrombosis and the surgery of the labyrinth. He was also a highly skilled anatomist, and doubtless his operative success was in some part due to this fact.

I remember once when I was staying with him going to see him perform a labyrinthine operation—now almost a thing of the past. The gallery was full of enquiring strangers, and he answered most courteously many intelligent and not so intelligent questions. But when he was asked : "And how, Sir William, do you avoid the facial nerve ?" his exasperation got the better of him and he snapped out : "Oh, luck—just luck !" He did not suffer fools gladly but was ever in the van of progress.

WATSON WILLIAMS, of Bristol, was an early investigator of sinus disease, more particularly in relation to the organism as a whole, and I think that we owe our appreciation of focal sepsis with all its implications mainly to his work.

And now let me turn to some of those associated during this period with this National Hospital, or rather with its component parts, and I could select from the many as outstanding StClair Thomson, Dan McKenzie, Herbert Tilley and Dundas-Grant. A wide knowledge, clinical acumen and intense appreciation afforded them the possibility of adding to our store.

The name of STCLAIR THOMSON will always be associated with cancer of the larynx, since it was his pioneer work that opened up the possibilities of laryngo-fissure and transformed what was regarded as a dangerous and almost fatal operation into a safe and successful procedure. He had many other claims to fame, and amongst his earlier investigations those on cerebrospinal rhinorrhœa and his many papers on tuberculosis

The End of an Era

should not be forgotten. He also helped to elucidate the curious condition that is called congenital laryngeal stridor, in which there is an exaggeration of features present in the normal infantile larynx; a heated controversy raged as to whether the condition was a primary one or not. He was one of those who took the view that it was secondary, somewhat analogous to pigeon breast. He was, moreover, a leading authority on tuberculosis of the larynx, and his encyclopædic knowledge is enshrined in his well-known textbook.

DAN MCKENZIE was a prolific writer and added very greatly to our knowledge of brain abscesses of aural origin. He also devoted much time and research to the pathogeny of cholesteatoma, and from numerous specimens and clinical material came to the conclusion that the supposed origin from suppuration of the middle ear is an error based upon the misreading of the clinical and pathological data. He regarded the condition as always primary. In addition to this, he found time to conduct an elaborate anatomical investigation of the Fallopian aqueduct in its relation to facial paralysis: a large series of mastoid bones was used for the purpose and most minute and meticulous measurements were made as well as many beautiful preparations. A knowledge of this research would surely be helpful to those desirous of opening any part of the canal for decompression or nerve grafting.

It might also be remembered that McKenzie edited the *Journal of Laryngology* for many years and carried it successfully through the very difficult period of the first world war.

HERBERT TILLEY and James Dundas-Grant both began their careers as General Practitioners and both maintained that it was an invaluable preliminary training before they took up seriously their training in laryngology and otology.

Although Tilley did not, I think, make any outstanding contribution to our knowledge, he was one of those all-round men of large experience and ability who were so useful when the conduct of our specialty was emerging from the hands of general surgeons and physicians. His main interest was in Nasal Sinus disease and I will remember a great many years ago when he gave the Annual address in this room that he chose this for his subject, reviewing the current opinions and setting forth lucidly the position as it was at that time.

JAMES DUNDAS-GRANT now almost a legendary figure in the annals of Grays Inn Road, devoted himself to the welfare of this hospital for very many years and many generations of students owe a very great deal to his kindly help and advice. There were few branches of our specialty in which he was not profoundly interested and to whose problems he brought a wealth of learning and case lore. He was a great authority in tuberculosis of the larynx and retained his versatility and enthusiasm to the end of a very long life.

Walter Howarth

It will thus be seen that in this Island an exceptional amount of work of the highest quality was achieved and the ground well prepared for the rapid expansion that took place in our specialty in succeeding decades. It is not my wish to dwell on this middle period, fruitful though it has undoubtedly been in increasing many aspects of our knowledge and consolidating positions that had already been won. I would like to look forward and try to see what the future holds and in what way we should approach our aim.

Many of those whom I have mentioned based their conclusions on accurate clinical observations, the comparing of cases and a careful correlation of results. The rapid expansion of scientific method and the variety of its means of application have to some extent obscured the value of the older method, and it is sometimes difficult to keep pace with the ever-changing picture that may be presented to our minds.

One of our chief troubles is that those who have the knowledge—the scientists—so often lack experience, and that those who have the experience so often lack the knowledge that science has made available.

It is imperative that we should have at our disposal the means of acquiring and appreciating the advances that are being made.

It is one of the great and undoubted values of this Institute of Laryngology and Otology that by means of its library, its lectures and its various departments, it can afford this help and put one in the way of the very latest that science is doing for us. An appreciation of some recent advance may be the key to the explanation of some problem that confronts us. Let us take an example.

Over a century ago a Swiss scientist discovered that when he covered a bat's eyes it could still give a perfect example of blind flying, avoiding every obstacle with uncanny ability, but that when he covered its ears the bat remained obstinately grounded, and that when he could be persuaded to fly at all, his customary skill had departed and he blundered helplessly into everything in his path. It was not until the wartime development of Radar and Sonar and the use of the supersonic wave analyser that the secret of the bat's uncanny powers was revealed. This apparatus which can detect and measure noiseless vibrations far above the highest note apparent to the human ear revealed that the bat when in flight sends out an interrupted train of high frequency sound, generally through its mouth although in some cases the nostrils are used.

These vibrations are reflected from objects in their path and return to the bat as an echo. As the time interval between the transmitter squeak and its echo is proportional to the distance from the reflecting body, the bat is able to fix his position with great accuracy.

In Radar and Sonar equipment the receiver is suppressed whilst the transmitter is sending so that only the echo is received. Nature has

The End of an Era

interconnected the powerful larynx and the sensitive ear of the bat to produce the same effect.

Each time the bat's supersonic squeak is being transmitted a muscle at the base of the ear is contracted, rendering the bat deaf to its own voice: at the end of transmission the muscle relaxes and allows the returning echo to be received.

The periods of transmission last for only one two-hundredth of a second and occur up to sixty times in a second. Each transmitter impulse consists of a train of supersonic sound of a frequency in the neighbourhood of 50,000 per second.

Perhaps the most astonishing thing about the bat's echo sounding system is its accuracy and power of discrimination far ahead of our best Radar achievements.

If, as in this instance, electrotronics may be used to explain the aural mechanism of a bat's flight, its possible use in our service might well be borne in mind.

An appreciation of chemical advances enabled those who were aware of their significance to initiate the rise of chemotherapy and so to harness to our use this most valuable agent, and then again biochemistry with the study of vitamins and proteins may help us to unravel some of the many difficult problems of Allergy that seem to play such a large part in nasal disease. The present concept of allergy seems to be that allergens produce on sensitized cells an effect causing the liberation of histamine or of a histamine-like substance, so that it behoves us to familiarize ourselves with, and further explore the possibilities of, substances which may combat the action of histamine.

So it goes on and we should endeavour to keep ourselves in line with current thought and so leave our minds open to fresh ideas that might usefully be transferred to our special needs.

I have only mentioned a few of the branches of scientific enquiry to show how much better equipped we should be than our predecessors for the investigation of disease but I think that there may be some danger in this approach if it is not at the same time closely associated with the older method.

Clinical observation and experiment were the basis of John Hunter's magnificent work and discoveries and still today should be our mainstay if we are to arrive at a satisfactory solution of the problems before us.

A recent writer has said that observation might be called the examination of nature, noting the data that lay open for inspection, whilst experiment might be called the cross-examination of nature, forcing from her by appropriate devices the answers she did not yield spontaneously. But observation in our specialty is not always an easy matter, and to perform it accurately requires considerable training. How often does one recall mistakes due to lack of observation, whether it be from hurried

Walter Howarth

examination or from lack of ability to look properly or to appreciate what it is that one is looking at.

It will, I think, be found that careful observation conscientiously carried out is to some extent progressive and that the mind unconsciously synthesises previous observations with the picture in front of us—so that the beginner may exclaim: “But how do you see all that?” and it is difficult to explain.

I well remember, nearly forty years ago, seeing a laryngeal case with Sir Felix Semon, then an old man. It was a growth on a vocal cord of rather unusual character, and he said that it was cancer; and when I asked him why he thought so, he said: “Well, it looks like it to me”. He was doubtless observing many things that I could not then see myself.

We *can* train our power of observation, and we must endeavour ceaselessly to perfect this power.

But we must also experiment. You will remember John Hunter’s famous remark: “Why think? Why not try the experiment?” and Harvey’s exhortation to the Fellows of his College: “To search and study out the secrets of nature by way of experiment.” This word experiment often connotes—particularly to the lay mind—experiments on animals, but that is to take too limited a view. As the American philosopher William James said in one of his essays: “Many persons nowadays seem to think that any conclusion must be very scientific if the arguments in favour of it are all derived from the twitching of a frog’s legs—especially if the frogs are decapitated—and that on the other hand any doctrine chiefly vouched for by the feelings of human beings—with heads on their shoulders—must be benighted and superstitious.”

I should be the last to decry the usefulness of laboratory experiments. In many ways they are essential to our needs and we should exercise our ingenuity in adapting their possibilities; but there are also other kinds of experiment open to us, and an endless variety of clinical experiments with the co-operation of our patients may be devised and undertaken and many problems solved in this way. Let us always remember that “If the question is not asked, an answer cannot be expected.”

I have tried in a limited way to recall some of the achievements of the past and feebly to indicate some lines along which we may face the future; and so—encompassed as we are by so great a cloud of witnesses to the truth—let us press forward expectantly to our goal.

“To travel hopefully is better than to arrive, and the true success is to labour.”

SEPTICAEMIA AFTER TONSIL OPERATIONS

By E. WATSON WILLIAMS (Bristol)

ACUTE septicæmia after tonsil operations is rare. Milne Dickie (1914) reviewed 7,000 operations carried out in Edinburgh Royal Infirmary during seven years: he reports two fatalities. A: Girl, 6, tonsillotomy; vomited day after operation; Acetone present, vomiting persisted; died on 7th day. Death considered due to delayed anaesthetic poisoning. B: Girl, 7, tonsillectomy; vomited next day, T. 100.2° F., second day collapsed, tongue dry, pupils dilated, no haemorrhage; died, no autopsy, "Probably status lymphaticus". In both cases the description strongly suggests acute septicæmia as the correct diagnosis.

Ewart Martin (1922) reviewed a further 8,000 operations in the same hospital and noted the two cases already given. There were four deaths, three from bronchopneumonia. The third child gave no immediate cause for alarm but was admitted a week later with swelling in leg and fever and died on 16th day: "septic absorption" i.e., presumably pyæmic abscess.

Ogilvie (1929) reviewed operations at Great Ormond Street Hospital during six years, in which "over 5,000" operations were done each year, i.e., a total of 30,000. There were five cases of pyæmia, starting usually after 2-3 days: malaise with sudden rise of temperature, pneumonia, otitis media, haematuria: in 3 cases pneumococcus was grown from blood, in 2 streptococcus from urine. A sixth child had rapid and sudden illness without local manifestations, and died 48 hours after operation; streptococci were recovered from blood post-mortem: apparently a true acute septicæmia.

Tilley (1919) writes: "The graver types of infection (following tonsil operations) such as general septicæmia have never been seen by the author." But referring to removal of adenoids "General septic infection is not so infrequent as could be desired . . . septicæmia may follow and fatal results are not unknown . . . Two cases of adenoids were operated on in one house and both were followed by symptoms of acute septic poisoning: one child died and the second barely escaped with his life. It was shown that the air in the room was contaminated by an escape of sewer gas under the floor".

When I was house-surgeon to Sir StClair Thomson he related the case of two small brothers whose tonsils and adenoids were removed in hospital. They returned home immediately after operation and both developed fulminating septicæmia. One died on the second day, the other eventually

E. Watson Williams

recovered. They lived in poor rooms over a stable and this was considered the explanation for this unexpected disaster. I have always understood that these children were operated on in the out-patient department of King's College Hospital, though not by Sir StClair Thomson himself: and that the report had been published. But I have completely failed to find the report, and am therefore in some doubt. In the third edition of his book (1928, p. 356) he refers to Ewart Martin's paper, but had apparently never himself encountered acute septicæmia in 32 years: unless there is an oblique reference to the history just given in his sentence on page 93, " septic infection in exposed wounds of the air passages may be traced to insanitary surroundings".

It is at once apparent that the two accounts given immediately above may well refer to the same children, despite certain differences. I have certainly always believed that these were two *different* disasters. If so, the resemblance is very close.

Realizing that I have just completed 10,000 tonsillectomies I have been analysing the complications: and thought it useful to publish the only two cases of septicæmia in my series. Since I was appointed in charge of the Department at the Bristol Royal Infirmary in 1928, at least double that number of operations (and probably considerably more) must have been done in addition, since the proportion that I have performed myself is small. The last two cases reported below are the only two cases of septicæmia from the additional (?) 20,000 operations.

Case I.

In March 1943 I saw in the out-patient department two brothers. Kenneth C. aged 5, suffered from sore throat and difficulty in swallowing. His tonsils were very large, but otherwise he appeared fairly healthy. He was admitted a few days later and removal of tonsils and adenoids was carried out (open ether). The operation presented no features of interest. He was quite well next day at 9 a.m. but soon after became very miserable and ill. By 1 o'clock temperature was 101.4°. There was no local explanation, but Dr. Richard Clarke saw him for me and considered he was suffering from severe toxæmia. He was treated by injections of anti-scarlatinal serum for three days. On the fourth day temperature was normal and he was obviously much better, and a week later he returned home quite well.

Case II.

Tony C. aged 4, was brought to out-patients on the same day as his brother. The main complaint was " convulsions ". He was rather a weedy child, with very big tonsils but otherwise appeared in fair general health. He was admitted at the same time as his brother and tonsils and adenoids removed during the same operating session: the operation

Septicæmia after Tonsil Operations

presented no special features but I see the note "rather deep anæsthetic". At 11 p.m. (7 hours after operation) he had acute diarrhoea and vomiting which persisted through the night. (No blood in vomit.) At 7 a.m. next day he had an "attack"—respiratory distress, cyanosis. This passed off. At 10 a.m. he was unconscious and incontinent. Temperature 100°, R. 60, P. 140. The temperature rose at midday to 107° and the child died without recovering consciousness. At autopsy we found nothing beyond manifest signs of acute septicæmia: blood culture grew streptococci.

The next two cases were treated not by myself but by a junior member of the medical staff in the Department under my care. There may be some significance in the mild pyrexia recorded in both patients two days before the operation: but this had resolved on the day preceding the operation and there was no obvious reason for postponing it.

Case III.

Eileen E. aged 4, was admitted on 4.10.37 and found to have a temperature of 100° F. Next day it was 98° and the child seemed quite placid. Tonsil and adenoid removal was carried out under open ether on 6th: the operation presented no features of importance. That evening her temperature rose to 102° F. and during the night she began to vomit. Next morning she was still vomiting and there was a little bleeding (ascribed to straining): she looked ill. Concentrated anti-streptococcal serum 3 c.c. was injected, and proseptasine given by mouth (half gramme ter in die). This treatment was repeated for three days during which she rapidly improved, and she went home, quite restored, on October 11th.

Case IV.

Barbara E. aged 5, was seen in out-patients with her sister Eileen, and admitted at same time, October 4th. On admission her temperature was 100° F. but it fell next day and was 99° F. on 6th. On that day tonsils and adenoids were removed (open ether): nothing notable. Her temperature was 98·2° F. that evening and she seemed well: next morning it was 98·6° F. She began to vomit and slight bleeding occurred: treatment as for Case 3. Her condition did not improve, and on 8th, temperature was 100° F. On 9th there was severe vomiting followed by brisk bleeding and collapse. Blood transfusion was started but she had a rigor: T. 101·6° F., P. 160: later T. 105° F. She was given injections of soluseptasine as she did not retain proseptasine tablets. By October 14th she was much better, T. 99° F. On 18th she had further fever with bronchitis and swollen elbow joint. Further injections of soluseptasine were given daily. The temperature remained high, with morning remissions, but she seemed to be improving. On 25th, the chest

E. Watson Williams

condition had cleared up but she was profoundly anaemic and looked very ill. The elbow joint was less swollen : a sinus opened in the R. thigh (? site of an injection) and discharged pus. A second transfusion was given (700 c.c.). Early next morning she collapsed and died, three weeks after operation.

Autopsy. Tonsil fossae clean and healed. Pyæmic abscesses in L. lung ; liver, spleen, soft, "typically septic" ; heart, kidneys normal ; some purulent exudate in abdomen ; L. elbow joint contained pus ; sinus in R. thigh quite superficial.

That in quite large series of operations so few cases of acute septicæmia occur shows how rare is this complication. At the onset it is easy to make a mistake in the diagnosis : the most striking features being vomiting, perhaps diarrhoea, and collapse. It is to be hoped that with modern methods treatment will be more satisfactory. But the really curious point is that this very rare complication has been recorded three times (four, if Sir StClair Thomson's cases are different from Tilley's) in pairs, each pair composed of two small children from the same family. Was each pair on the point of developing acute streptococcal tonsillitis ? If that is the explanation it is difficult to see how these accidents can be avoided, and why have we not more numerous isolated examples of this complication ? But "accidental coincidence" is hardly a credible explanation.

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ON THE EVOLUTION OF THE AUDITORY CONDUCTING APPARATUS—I.

A NEW THEORY BASED ON FUNCTIONAL CONSIDERATIONS

By A. TUMARKIN (Liverpool)

Introduction

THE problem of the evolution of the middle ear has been of abiding interest to morphologists. An enormous amount of work has been devoted to it, based in the main on three sources of information. Firstly, embryology provides the data for an ontological approach. Morphology is then invoked to compare the structures in various animals and finally the evidence of palaeontology is brought in. This provides the family tree—the phylogenetic view point. Unfortunately, owing to the very wide gaps in our knowledge, the method does not yield precise results and deductions are often based on flimsy evidence. A more serious criticism of standard theories is that they pay insufficient attention to the functional aspect of the problem.

It is perhaps too much to hope that we shall ever understand exactly why in the course of evolution, a given structure undergoes its various modifications. Nevertheless, it is implicit in any conception of evolution that such modifications are related to the functional efficiency of the structure i.e., its survival value.

In the case of the middle ear we are dealing with a complicated structure which has been of very great importance in the struggle for survival. The mammalian middle ear in particular is an exquisite and highly efficient structure and we expect to find in tracing out the main course of evolution that it has progressively evolved towards that perfect stage through more crude intermediate stages. The transition was presumably continuous. That is to say there were no sudden jumps of an extreme nature. Furthermore, it should be possible to show that the intermediate stages were reasonable—that is to say they should not contradict the laws of physiology and physics.

I propose in this article to show that the text book account of the evolution of the middle ear is not "reasonable" and I offer in its place an account which seems to fit the functional requirements much more closely without doing any violence whatsoever to the available ontogenetic and phylogenetic evidence on which orthodox theory is so exclusively based.

A. Tumarkin

In conformity with this emphasis on the "Functional" approach to the problem, I have chosen to speak of the auditory conducting apparatus rather than of "the middle ear" because the latter expression is commonly regarded as synonymous with the tympanic membrane, cavity and ossicles etc., as found say in mammals, frogs and most reptiles. These are, however, by no means the only mechanisms available for the transmission of sound from the environment to the inner ear.

The Weberian system of the ostariophysci (Ref. 4, 18, 19) and the various auditory sensilla of the insects (Ref. 13) are cases in point. Even limiting ourselves for the purpose of this paper to the terrestrial vertebrates we shall find at least four other mechanisms worthy of recognition. These systems—although undoubtedly less sensitive and less efficient than the middle ear proper, must nevertheless be considered as independent entities and it is the purpose of the present paper to demonstrate how they have all arisen out of the primitive structures of the Stegocephalia in response to various biological and physical forces. The problem is thus approached from a functional rather than a purely morphological or phylogenetic point of view.

The auditory conducting mechanism is therefore defined as consisting of all those structures which intervene between the sound wave in the environment and the neuro-epithelium of the inner ear. The term "environment" includes air, water and ground.

Mechanically, the middle ear may be sub-divided into :

- (a) The collecting component (in mammals this comprises pinna, external auditory canal and tympanic membrane).
- (b) The transmitting component (in mammals this comprises malleus, incus and stapes).
- (c) The terminal component (the oval window and perilymphatic duct and fluid).

This paper deals with the evolution of components (a) and (b).*

Morphological Data

A survey of modern animals reveals the following six clear cut distinct auditory conducting mechanisms.

1. *V.Sq.=Vestibulo Squamosal* (Fig. 1a). This is found in urodeles.† The columella stretches from oval window to the squamosal. It is a bone conducting mechanism. The animal picks up vibrations by direct contact between the skull and substrate. There is no tympanic membrane and no middle ear cavity.

2. *V.Q.=Vestibulo Quadrate* (Fig. 1b). Found in snakes—some lizards and many extinct reptiles. This resembles V.Sq. but the

* Component (c) has already been dealt with in a previous article in this journal (Ref. 18).

† *Urodeles*=crawling amphibia, e.g. newts and salamanders.

Evolution of Auditory Conducting Apparatus

columella is attached externally to the quadrate. Vibrations are transmitted *via* the lower jaw and articulo-quadrata joint.

3. *V.S.* = *Vestibulo Scapular* (Fig. 1c). This remarkable mechanism is only found in urodeles and anura.* It consists of an operculum, i.e.,



FIG. 1A.

FIG. 1A.—*V.Sq.* A primitive bone-conducting mechanism.

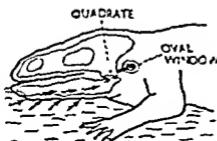


FIG. 1B.

FIG. 1B.—*V.Q.* A primitive bone-conducting mechanism.

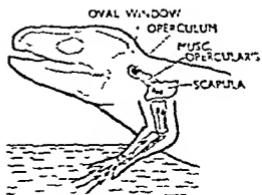


FIG. 1C.

FIG. 1C.—*V.S.* An intermediate bone-conducting mechanism.

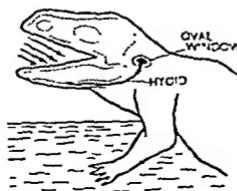


FIG. 1D.

FIG. 1D.—*V.H.* A primitive air-conducting mechanism.

a plaque of cartilage lying in the oval window posterior to the true stapes. The *musculus opercularis* runs from the operculum to the scapula. Vibrations in the substrate pass *via* the fore-paw to the scapula and thence *via* the opercular structures to the vestibule. This is also a B.C. mechanism.

4. *V.H.* = *Vestibulo Hyoid* (Fig. 1d). i.e., hearing *via* the buccal cavity and the hyoid bone. In amphisbænids the stapes is continuous with the hyoid bone. These animals listen by opening the mouth. This is a crude form of air conducted hearing. The floor of the mouth acts as a tympanic membrane and the hyoid acts as an intermediate ossicle comparable with the incus and malleus of the mammal.

5. *V.T.* = *Vestibulo Tympanic*, i.e., hearing *via* a perfected drum and a single ossicle. In the highest amphibia, i.e., frogs and in most reptiles, e.g., crocodiles—turtles and many lizards, the stapes (usually called the columella) is a delicate spicule of bone lying freely mobile in a middle-ear cavity. Its inner extremity fits into the oval window—

* Anura = jumping amphibia, i.e. frogs and toads.

A. Tumarkin

its outer extremity is continuous with a cartilaginous extra columella, which is inserted into a perfected trilaminar drumskin.

6. *V.O.* = *Vestibulo Ossicular*. This is the mammalian triple ossicle system.*

Transitional Mechanisms

In addition to the above clear-cut mechanisms it is possible to recognize several transitional types. *Sphenodon*, a primitive New Zealand lizard represents a transition from V.H. to V.T. Its stapes not only connects with the hyoid but also with a "plaque" of fibrous tissue. This "plaque" is attached circumferentially to the opisthotic and squamosal, the outer plate of the quadrate, the posterior edge of the quadro-jugal, the retro-articular process of the lower jaw as well as the hyoid itself. It lies deep to the skin and subcutaneous tissues and for the most part is covered also by the *M. depressor Mandibulae*. The significance of this arrangement will be discussed later.

An even more interesting transition from V.Q. to V.T. is found in Agamid and Iguanid lizards: (Ref. 17)

(a) In the Chameleons there is no drum, its position being covered externally by muscle and skin. The columella auris or stapes is attached, by a long cartilaginous plate which joins it at right angles to the upper and lower extremities of the quadrate, i.e., pure V.Q.

(b) In *Holbrookia* (an Iguanid), the columella auris is unusually thick, and has neither dorsal nor ventral processes, it terminates in a knob, which is attached to the posterior surface of the quadrate bone. This similarly is pure V.Q.

(c) In the genera *Tympanocryptis*, *Aphaniotis*, *Cophotis*, *Lyriocephalus* and *Ceratophorus*, the tympanic membrane is covered by muscle an extension of the anterior branch of the *Depressor mandibulae*, the extra-columella is a mere vestige projecting from the stapes, and the dorsal and ventral processes have become ossified and unite the stapes to the quadrate. This is still mainly V.Q. but a crude fibrous plaque is appearing—similar to that of *Sphenodon*.

(d) In the genera *Otocryptis*, *Phyctolaemus*, *Phrynocephalus* and *Phoxophrys* and sometimes in *Draco*, *Japalura* and *Oriocalotes*, there is no visible tympanum, the membrane being covered by skin. Its place, however, is usually indicated by a depression and on stripping the skin away the membrane can be seen, together with the attached extra-columella cartilage. On looking into the pharynx the cavity of the middle ear is comparatively large, and the stapes which crosses it may be exposed, but never very completely. This is well on the way to V.T.

(e) In many Agamids the drum is well exposed, but even so the stapes tends to be held down in connective tissue—it is not completely air borne.

* I have based this nomenclature on the attachments of the stapes, i.e., internally to the vestibule, externally to the quadrate, hyoid, etc., as the case may be. In V.S. there is no stapes but the opercular structures determine the name.

Evolution of Auditory Conducting Apparatus

(f) In Gecko the stapes is a fragile spicule of bone only held by a delicate strand of supporting tissue. A perfect trilaminar drum is present*.

Thus the Lacertilia present all transitional stages from pure V.Q. to pure V.T. (see Fig. 9).

We shall also encounter later a transitional mechanism between V.Q. and V.O. No examples of this mechanism (which I call Vestibulo Mandibular V.M.) are extant, but it represents an intermediate stage between the V.Q. of the pre-mammalian reptiles and the V.O. of their descendants the mammals.

It is usual to regard Mechanism No. 1 to 4 as in some way degenerate. In the Lacertilia for instance, the Geckonidae are described as possessing "normal" middle ears. The genera in groups (a) (b) (c) and (d) are regarded as presenting various degrees of degeneration—the Chameleons and Holbrookia being completely degenerate. In the writer's opinion the reverse is the case. Holbrookia and the Chameleons have not improved on the primordial V.Q.—all the others show varying degrees of evolution towards the ideal V.T. Thus we shall find that V.Sq., V.Q. and V.H. are not degenerate forms of V.T.—they are antecedent to V.T. As for V.S.—we shall find that it has no direct relation to V.T. at all. It is a completely independent mechanism.

Many animals indeed use more than one mechanism. Sphenodon for instance uses V.H. but has developed primitive V.T. as well. Urodeles use V.Sq. in conjunction with V.S. and it is most significant that the relative importance of the two mechanisms can be closely correlated with the functional requirements. In the completely prostrate urodeles V.Sq. predominates whilst V.S. is rudimentary and may indeed be absent. In the more erect urodeles V.Sq. obviously is much less useful and becomes rudimentary whilst V.S. predominates.

Anura use V.S. in conjunction with V.T. and here again a certain degree of variation can be correlated with functional requirements. The tympanic membrane is most highly developed in terrestrial frogs. On the other hand toads which tend to walk rather than jump have not developed the drum to the same extent, being more dependent on V.S. In a few toads, such as *Bombinator*, there is actually no tympanic membrane—the animals relying entirely on V.S.

Phylogenetic Data

Fig. 2 shows the genealogical tree of the terrestrial vertebrates so far as it is relevant to the present problem. The earliest amphibia—the Stegocephalia first floundered on to land in the Devonian. They

* The above details are extracted from Smith's article (Ref. 17) but the interpretation of them as evidence of an evolutionary progression from a primitive to a perfect stage is part of the writer's theory. As will be shown later, Smith adopts the orthodox viewpoint that they are the result of degeneration.

A. Tumarkin

apparently evolved out of the crossopterygian fishes. Modern amphibia are sub-divided into the Caudata—or tailed species such as the newts and salamanders and the Salientia the tailless jumpers—Frogs and toads.

These are directly descended from the Stegocephalia.

In the Carboniferous the reptiles appeared—having evolved directly out of the amphibia. The first reptiles—the cotylosaurs (i.e. stem reptiles) were clumsy lumbering beasts but their improved respiratory and

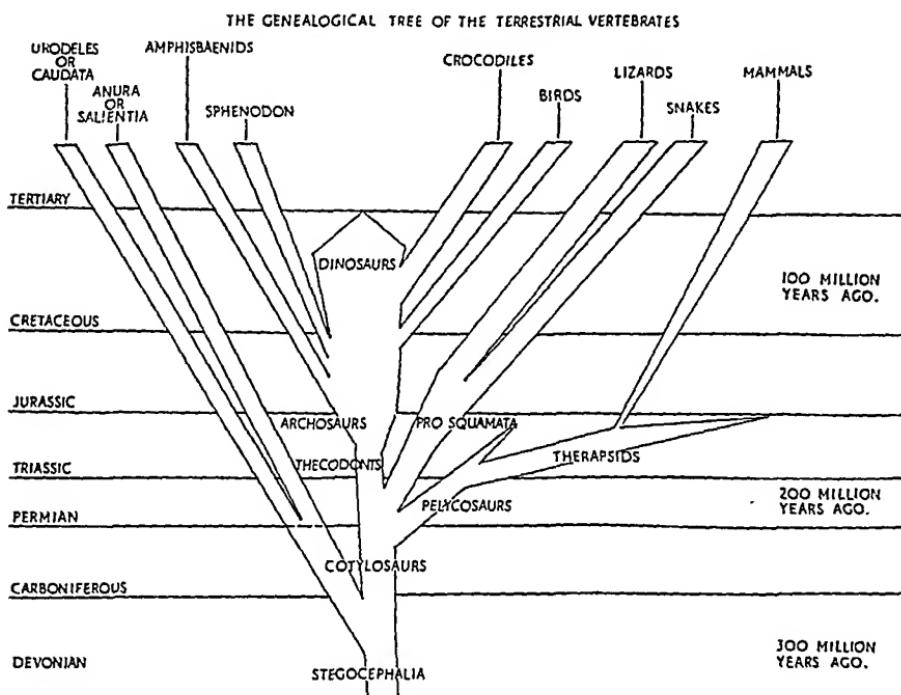


FIG. 2.—This figure only shows details in so far as they are relevant to the subject. No attempt has been made to allocate "importance" (e.g. as between frogs and mammals) and many large groups have been omitted.

reproductive systems gave them a great advantage over the amphibia so that the latter were thrust into the background. Then followed the era of the reptiles—the Mesozoic during which innumerable species flourished on land, in the sea and in the air.

For the purpose of the present discussion three main lines of reptilian radiation are to be noted—all of them arising out of the cotylosaurs.

1. The archosaurs—i.e. the dominant reptiles of the Mesozoic. These began as the thecodonts in the Permian. They gave rise to the dinosaurs which became extinct in the Cretaceous, although early offshoots are represented by the birds, crocodiles and possibly turtles.

2. The pro-squamata. These gave rise to the modern Squamata,

Evolution of Auditory Conducting Apparatus

subdivided into the Ophidia (snakes) and Lacertilia (lizards). Amongst the latter may be noted Sphenodon, the sole surviving representative of the Rhynchocephalia.

3. The pre-mammalian reptiles began with the pelycosaurs. These were the dominant types in the Permian quite overshadowing the thecodonts. They became extinct in the early Triassic having given rise to the therapsids. The latter had to encounter the dinosaurs and apparently proved unequal to the struggle, becoming extinct in the late Triassic. It seems clear that the therapsids gave rise to the mammals although the missing links have not yet been located.

Ontogenetic Data

It is not feasible to present systematically all the relevant ontogenetic evidence. Many points will be discussed as they arise, but two fundamental and well-established theses must be mentioned.

1. The stapes of the mammal is homologous with that of the reptile, both being derived from the 2nd visceral (i.e. the hyoid) arch.

2. The mammalian incus is homologous with the reptilian quadrate and the mammalian malleus is homologous with the reptilian articular. Thus the articulo-quadrata joint of the reptile is found in the mammalian middle ear as the incudo-malleal articulation. It is also generally believed that the columella of the Anura is homologous with that of the reptiles. In the writer's opinion this idea is erroneous and has contributed considerably to the confusion with which the whole subject is surrounded.

Text Book Theory

It would not be correct to say that complete unanimity has been achieved—nevertheless the following account represents fairly accurately the views of most modern authorities. The hyomandibular is the key to the whole conception. In the primitive fish it served to sling the upper and lower jaws from the skull. Primitive fish had no specialized auditory apparatus. The labyrinth, consisting of utricle, saccule and semicircular canals was essentially an organ of static and dynamic equilibration. By the time the earliest amphibia were invading land in the Devonian, they had developed dermal bones which provided full support for the upper jaw so that the hyomandibular was unnecessary. It therefore became available for the new function of hearing.

Recently Westoll (Ref. 22) and others have shown that the primitive hyomandibular was a complicated structure with 5 main attachments (Fig. 3).

1. The ventral process attached to the auditory capsule.
2. The dorsal process reaching upwards towards the dermal skull cap.
3. The quadrate process attached to the quadrate.

A. Tumarkin

4. The hyoid process attached to the cerato-hyal.
5. The opercular process reaching out towards the operculum overlying the gill clefts*.

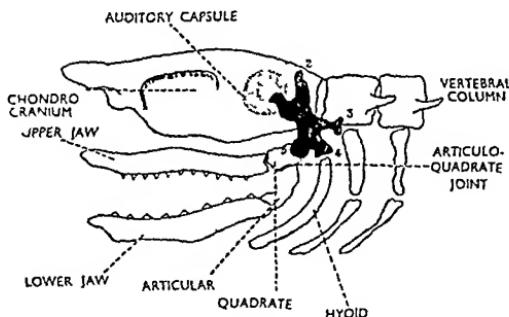


FIG. 3.—Cartilaginous Fish Skull showing five processes of Hyomandibular. 1. Ventral process (V.). 2. Dorsal process (D.). 3. Quadrat process (Q.). 4. Hyoid process (H.). 5. Opercular process (O.).

According to these authors the last three processes rapidly became rudimentary. The ventral process became the footplate of the stapes resting on the oval window which appeared as a thinned out area in the auditory capsule. The opercular process became the external portion of the stapes (or columella) because with the assumption of terrestrial

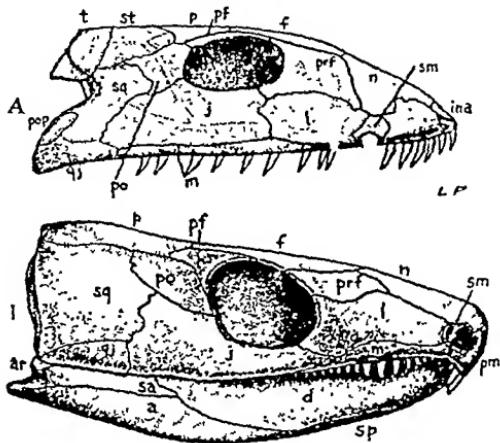


FIG. 4.—A : Lateral view of skull of *Ichthyostega* showing otic notch. B : Lateral view of skull of *Captorhinus* showing absence of otic notch. (From J. Gerrie, "Mammalian Tympanic Cavity and Auditory Ossicles, J. Laryng. & Otol., 1948, 62, 350, after Romer.)

* It should be carefully noted that this operculum has nothing at all to do with the opercular auditory mechanism of the amphibia.

Evolution of Auditory Conducting Apparatus

life the gills became unnecessary and the operculum disappeared thus leaving the opercular process of the hyomandibular quite superficial.

The tympanic membrane formed in the otic notch which (Fig. 4) lay between the tabular above and the squamosal below.

This is the middle-ear mechanism postulated for the early amphibia, i.e., the Stegocephalia. It was at one time believed that a gill cleft became directly transformed into the tubo-tympanic cavity by the simple growth of a tympanic membrane across its external orifice. This naive idea still occasionally appears in text books but is not entertained by any serious student of the problem. It is manifest that the transformation could not have occurred in such a simple manner because it does not provide for an "air borne" columella. The development of a perfected trilaminate tympanic membrane could not take place whilst the hyomandibular still lay enveloped in muscles. If a gill cleft produced the tubo-tympanic cleft (which the writer denies) it would first have to send a pouch to envelop the hyomandibular and render it air borne. This in fact is the theory propounded by Dr. Westoll. He envisages such a dorsally directed pouch in the amphibia enclosing the hyomandibular and terminating in the tympanic membrane at the otic notch.

The stapes was directed in a dorsal direction and to that extent bears some resemblance to the Anuran columella. Therefore the modern Anura are believed to derive their middle ear directly from the labyrinthodont Stegocephalia.

Fig. 5 shows the Stegocephalian stapes and also the hypothetical tympanic cavity in which it lay.

This conception of a primordial Stegocephalian V.T. mechanism is—in the writer's opinion—completely without foundation. We shall see later that it results in some quite fantastic paradoxes and it is difficult to avoid the suspicion that writers have quite uncritically started from the faulty premiss to which I referred in the introduction—namely that "middle ear" means middle-ear cavity plus ossicle plus tympanic membrane.

The procedure—in orthodox theory therefore appears to consist first in locating the "stapes". After that a hypothetical tympanic cavity is constructed around it and a drum is envisaged at the nearest suitable spot on the body surface.

This, for example, is the procedure adopted in the case of the cotylosaurs. Westoll says :

"At first sight the stapes of a primitive reptile (e.g., *Captorhinus*) is so different as to suggest quite other homologies. The main axis of the stapes runs postero-laterally and the connection to the quadrate is obviously the most important distal one. However, the distal end of the bone is not usually preserved and a short extra-stapedial projection may well have projected to the region of the tympanum, as in the cotylosaur, *Milleretta* and the

A. Tumarkin

Therapsids described by Brook. These conditions are related to the extraordinary downward spreading of the paroccipital plate in these reptiles and their derivatives, correlated with a downward drag of the tabular (and supratemporal) and complete obliteration of the original opercular or otic notch."

It should be noted that orthodox theory offers no definite site for the Cotylosaurian drum. The Stegocephalian otic notch has been swept away and is no longer available. The stapes is mainly attached to the

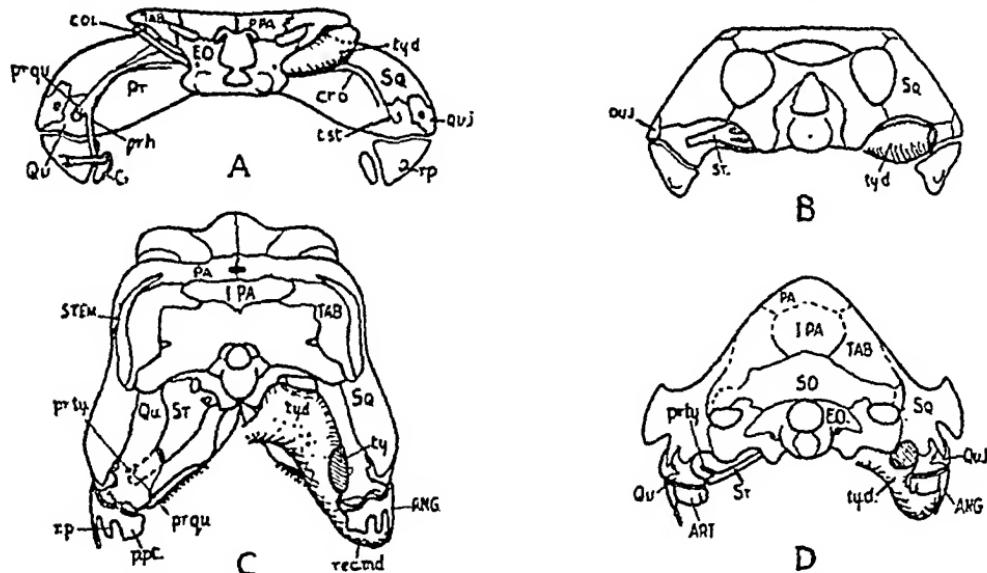


FIG. 5.—ATTEMPTED RECONSTRUCTIONS (SCHEMATIC) OF TYMPANIC DIVERTICULA IN FOSSIL TETRAPODS.

A: The stegocephalian *Benthosuchus*, adapted from Bystrow and Efremov. B: The cotylosaur *Captorhinus*, adapted from Sushkin, Price and others. C: The pelycosaur *Dimetrodon*, adapted from Romer and Price. D: The Therocephalian *Lycedops*, adapted from Broom. In each figure the columella auris or stapes is shown on the left side, the tympanic diverticulum on the right. Col—St—Columella (or stapes). Ty.d.—Tympanic diverticulum. Ty—Tympanic membrane. Qu—Quadrata. Sq—Squamosal. (From T. S. Westoll, *Proc. roy. Soc. B.*, 1943, 131, 393.)

quadrate but despite that the possibility that those animals heard by V.Q. is never considered.

Automatically a middle-ear air space is created and a suitable cartilaginous extra-columella is postulated-reaching out to a tympanic membrane situated on the surface somewhere in the neighbourhood of the posterior end of the lower jaw.

Passing from the cotylosaurs—orthodox morphologists seem to have interested themselves almost exclusively in the phylogeny of the mammalian middle-ear structures. It is true that these present problems of absorbing interest—nevertheless in the writer's opinion, much of the fundamental weakness of orthodox theory can be ascribed to this anthropocentric pre-occupation.

Evolution of Auditory Conducting Apparatus

It is, for example, a quite remarkable fact that the Dinosaurian stapes has never been found. Despite the enormous size of the dinosaurs, and despite the great number of species which has been studied the Archosaurian stapes has never been located. Lull and Wright in their study of Hadrosaurs say (Ref. 12) :

"It is regrettable but not surprising that the actual bony stapes has apparently never been recorded in dinosaurs."

These authors gave no indication as to why the fact should not be surprising. In the writer's opinion—so far as orthodox theory goes, it is more than surprising—it is quite inexplicable. It cannot be doubted that the dinosaurs did have adequate hearing and no theory of the auditory conducting mechanism can be regarded as complete which fails to explain this remarkable if negative fact.

Similarly—with regard to the evolution of the middle ear of the pro-squamata, little or no direct reference is found in standard text books. It seems to be tacitly assumed that the Cotylosaurian V.T. mechanism was duly perfected and handed down to their modern representatives. It follows from this faulty premiss that all modern squamata which do not now possess V.T. must have abandoned it in the past, i.e., they must be degenerate. This is a fundamental issue which will be discussed in detail later on.

Lastly, we reach the problem of the phylogeny of the mammalian middle-ear mechanism V.O. The unravelling of this fascinating problem has undoubtedly been one of the most brilliant triumphs in the whole history of morphology.

The broad outline of the solution is no longer in question. In the mammal the lower jaw consists of a single bone—the dentary. In the reptile the lower jaw is a composite structure comprising a number of bones—dentary, splenial, angular, articular, pre-articular, etc. in synostosis.

The mammalian lower jaw hinges on the squamoso-dental (i.e., temporo-mandibular) articulation. The reptilian lower jaw hinges on the articulo-quadratae articulation. Thanks to the monumental work of Reichert, Gaupp (Ref. 5) and many other workers it has been proven that the reptilian jaw joint is represented by the mammalian incudomallear joint, as outlined on page 125. Here again, however, whilst the morphological data can be readily accepted, the orthodox phylogenetic deductions from those data are open to grave criticisms. The difficulty arises—as before—from the fallacious assumption of a middle-ear cavity and tympanic membrane in the cotylosaurs. This naturally leads to the assumption of similar structures in the pelycosaurs and therapsids. The problem which now confronts us is : How (and why) did the reptilian monossicular V.T. mechanisms turn into the mammalian triple ossicle

A. Tumarkin

V.O. It should be noted that two distinct processes are involved. First—the reptilian stapes must have somehow separated itself from the tympanic membrane (because the mammalian stapes does not contact the membrane) and secondly—into the gap—the reptilian jaw joint bones must have become interpolated. From a functional point of view this conception is completely repugnant. If the therapsids possessed a V.T. mechanism of any reasonable efficiency such a metamorphosis would invoke serious loss of efficiency during the intermediate stages. This disregard for functional considerations has already been noted as a characteristic defect in orthodox theory. It will be discussed in more detail later—for the present we merely note the orthodox theory “explains” the transition from V.I. to V.O. by simply saying that the reptilian tympanic cavity continued to spread round the obsolescent articulo-quadratus joint and that in due course a mammalian tympanic membrane formed in association with the articular. The stapes subsequently lost contact with the reptilian drum, and re-attached itself to the quadratus which itself was in process of turning into the incus.

It thus appears that orthodox theory is based exclusively on the evidence of palaeontology and of embryology and little or no regard is paid to the functional implications of the various proposed transitions from one stage to another.

Now in tracing the history of an organ as important as the ear we expect to find, on the whole, a progressive improvement in efficiency.

And yet as we shall see later the orthodox theory involves transitions of a disastrous inefficiency. This criticism—standing alone—would perhaps carry little weight—but we are surely entitled to introduce the criterion of function and of two rival theories to choose the one which (other things being equal) complies more harmoniously with its requirements.

Thus we aim at a theory which will

i. Base itself on a comprehensive survey of all vertebrate auditory mechanisms.

2. Avoid an anthropocentric pre-occupation with the tympanic membrane and cavity.

3. Introduce the criterion of function. How and why did the transitions occur?

Functional Theory

We start, therefore, at the Devonian era with the evolution of the amphibia. The earliest types, such as *Eogyrinus* (Fig. 6) lived mostly in water—only venturing on to land when their shallow lagoons dried up. They had no specific auditory endorgan. The utricle and saccule were present but they were essentially organs of static equilibration. The arrangement of a massive otoconium and sensitive neuro-epithelium primarily acting as a gravity receptor would also (by accident—so to

Evolution of Auditory Conducting Apparatus

speak) respond slightly to the push and pull of acoustic vibrations, especially those of low frequency. Thus *Eogyrinus* when in water probably heard vibrations up to 200 cps. (which is about the upper range of the *undifferentiated saccule* in modern fish). This function requires no middle-ear mechanism and in particular no oval window, the labyrinthine end organ lying completely enclosed within the cranium. Acoustic energy passes easily from the enveloping water into the skull because the physical characteristics (the impedance) of water and of living tissues are of the same order of magnitude. When the animal floundered onto land it was no longer homogeneous with its surroundings. Air borne sound could hardly enter the body at all. Vibrations in the

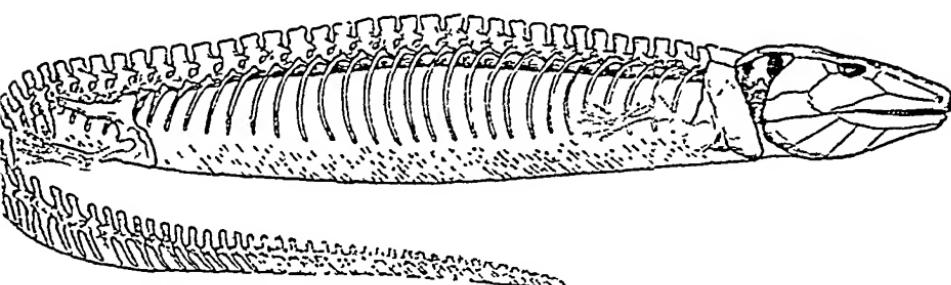


FIG. 6.—*Eogyrinus*, a Carboniferous embolomerous amphibian, estimated length about 15 ft. (After Gregory, modified from Watson) (Reproduced by permission)

substrate were better matched, but even so the transfer efficiency was poor, and the stage was set for the development of a true auditory conducting mechanism.

The problem centres mainly around the metamorphosis of the hyomandibular.

Fig. 3 shows its 5 main processes.

1. The ventral process (V) attached to the auditory capsule (i.e., the cartilaginous boss overlying the labyrinthine endorgan).
2. The dorsal process (D) reaching up to the dermal skull bones (i.e., the helmet of bones—frontals, parietals, squamosals, etc., which overlay the chondrocranium).
3. The quadrate process (Q) reaching the articulo-quadrate joint.
4. The hyoid process (H) joining with the cerato-hyal.
5. The opercular process (O) reaching out to the operculum (which is the plaque of bone overlying the gills).

Once the oval window developed as a "softening" of the auditory capsule, the ventral process (V) naturally became the footplate of the stapes and it is easy to see how in combination with the other processes, D, Q and H, it could give rise to certain of the mechanisms which we have already recognized.

A. Tumarkin

Thus $V+D=V.Sq.$

$V+Q=VQ.$

$V+H=VH.$

We may say therefore, that the early amphibia possessed V.Sq., VQ and VH in a potential or rudimentary form and that subsequently different groups of their descendants specialized in one or other of the mechanisms. One group abandoned the quadrate and hyoid connections—remaining content with V.Sq. giving rise to the urodeles. Another group specializing in V.H. is represented today by the amphisbaenids. A third group—specializing in V.Q. is represented by snakes and some lizards.

This analysis only accounts for the crudest mechanisms in the least progressive of animals and we still have to account for the V.S. mechanism of the amphibia and the exquisite A.C. mechanism of the Sauropsid and of the mammal.

We start with a hypothetical amphibian which had specialized in V.Sq. It listened by thrusting its head into the mud so that vibrations passed into the dermal skull bones. Thence along the dorsal process of the hyomandibular to the ventral process and so to the inner ear.

Such a mechanism was well suited to early amphibia which were all prostrate. Inevitably, however, certain later groups developed a tendency to *stand up* thus rendering V.Sq. useless. A new auditory conducting route had to be developed, and in the group we are considering the nearest available bone conducting route was chosen, i.e., the fore-paw—scapula and crano-scapular muscles. It should be noted that this route was also present *potentially ab initio*—but only became perfected when preceding mechanisms failed.

Much of the shoulder girdle musculature arises near the auditory capsule (compare the human trapezius and sternomastoid, etc.) and it is easy to see how a small slip of muscle attached to the lip of the oval window became segregated. In particular its cartilaginous attachment became detached to act as a plunger in a subsidiary window. Thus it is that all modern urodeles show V.Sq. and V.S. to a varying degree—the variations being closely related to the posture of the animal.

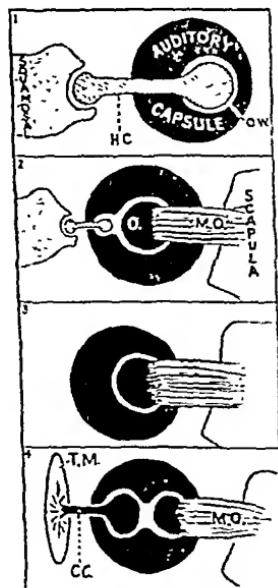
The process seems to have gone a stage further in the Anura (Fig. 7) in which no trace of V.Sq. remains. A few toads like *Bombinator* only possess V.S. but most toads and probably all frogs possess V.S. and V.T. We envisage a stage in these more erect animals when V.Sq. had completely disappeared—they depended mainly on their bone conducting V.S. hearing but were also beginning to evolve a crude form of A.C. hearing.

Once again we note that the requisite mechanism was present *potentially ab initio*.

Evolution of Auditory Conducting Apparatus

Although air borne sound striking the skull was almost entirely reflected—nevertheless a minute fraction did enter (just as an individual with both ears completely plugged is not *absolutely* deaf). Such a crude mechanism could obviously be perfected by the development of an oval window with its own cartilaginous plunger especially if the plunger could be energized by the sound energy collected in a relatively large drum.

Thus the Anuran V.T. mechanism exists side by side with its V.S. mechanism and consists of a columella (which like the operculum is



Pure V.Sq. found mainly in the prostrate urodeles. It is suggested that this was the primordial mechanism of the ancestral urodeles and the ancestral Anura.

V.Sq. + V.S. found mainly in the more erect urodeles. The hyomandibular columella has become much less important. The operculum develops out of the auditory capsule.

Pure V.S. found in erect urodeles and also in some toads. The hyomandibular has disappeared. This suggests that the anuran ear has evolved along the same lines as the urodelan but has travelled further.

V.S. + V.T. found only in Anura. If Anura reached this stage via stage 3 they had lost their hyomandibular columella and so had to evolve a new columella out of auditory capsule.

URODELA
NECTURUS
AMPHIUMIDÆ
CRYPTO-
BRANCHUS
SALAMAN-
DRA
AMBLY-
STOMA
TRITON
DIEMICYLUS
SIRENÆ

BOMBINA-
TOR and
a few other
TOADS

Many
TOADS
and most
FROGS

FIG. 7.—THE AUDITORY MECHANISM OF MODERN AMPHIBIA.—V.Sq., V.S. AND V.T. (Functional theory.)

Functional theory suggests that modern Amphibia represent various stages in evolution. Orthodox theory declares that modern Amphibia represent various stages of degeneration.

H.C. Hyomandibular columella.

M.O. Musc. opercularis.

O.W. Oval window.

C.C. Capsular columella.

O Operculum.

T.M. Tympanic membrane.

derived from the auditory capsule) attached externally to a large tympanic membrane.

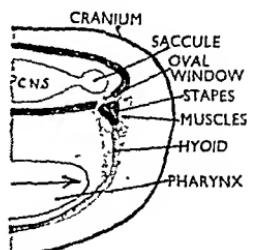
It is important to note that on this theory the Anuran columella is derived from the auditory capsule, the argument being that by the time the Anura came to develop V.T. they had completely lost the hyomandibular.

The V.T. mechanism as found in birds, crocodiles, turtles, etc. today has almost certainly evolved through the intermediate stage of a V.H. mechanism. In *Sphenodon* we actually see such a stage. This animal

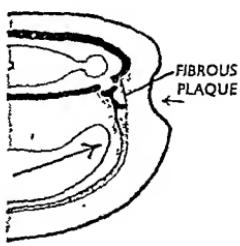
A. Tumarkin

picks up vibrations on the one hand *via* the floor of the mouth and the hyoid and on the other hand by means of the facial plaque, which has already been described.

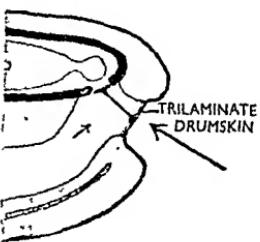
It is easy to envisage the transition continuing, the hyoid connection becoming less and less important whilst the definitive tympanic membrane developed by an approximation of the pharyngeal mucosa internally—to the skin externally (Fig. 8). It should be noted that Sphenodon



Stage I.—V.H. as found in amphisbaenids. The stapes is a solid conical mass overlain by muscles and articulating with the hyoid. Arrows indicate path of sound conduction (a).



Stage II.—V.H. + rudimentary V.T. Present in Sphenodon. The stapes has become smaller. It is still connected with the hyoid but it also sends a process to a plaque of fibrous tissue in the overlying muscles. The animal still mainly hears *via* the mouth but the plaque is faintly sensitive to external airborne sounds (b).



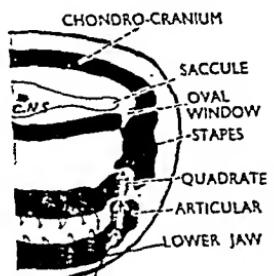
Stage III.—Perfected V.T. The stapes is extremely delicate and air-borne. A true tympanic membrane is present. The middle ear opens widely on to the pharynx (c).

FIG. 8.—The transition from vestibulo-hyoid to vestibulo-tympanic hearing.

mainly hears *via* its mouth and in the writer's opinion that represents the usual way whereby air borne vibrations were *first* picked up. A similar mechanism will be described later to account for the development of the mammalian triple ossicle system. It is thus a profound mistake to think of hearing in primitive animals in terms of a superficial tympanic membrane placed on the surface of the skull. The earliest tympanic membranes developed in relation to the mucosa of the bucco-pharynx. They were overlain by the mandibular musculature and only reached the exterior when those muscles receded.

Evolution of Auditory Conducting Apparatus

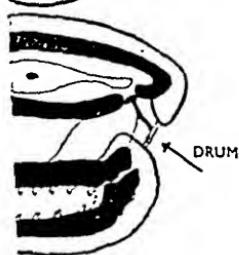
The transition V.H. to V.T. does not account for all reptiles by any means. It seems probable that the Squamata derived their V.T. mechanism by transition *via* a V.Q. mechanism (Fig. 9). This suggestion is based on the findings in modern lizards which have already been quoted. Once more we note that the primitive tympanic membrane (or rather its middle fibrous layer) was laid down as a fascial condensation in the mandibular muscles. At first it was closer to the pharyngeal mucosa than to the skin. Gradually the major attachment of the stapes



Vestibulo - quadratus. — Note massive stapes overlain by muscles and articulating firmly with quadratum. Arrows indicate path of sound conduction (a).



V.Q. + rudimentary V.T. as in *Lyriocephalus*. Note the rudimentary tympanic membrane in the masticatory muscles. The stapes is smaller. The epipharynx sends a pouch towards it (b).



Perfected vestibulo-tympanic. The muscles have receded. The drum has reached the surface. The stapes is delicate and air-borne (c).

FIG. 9.—The transition from vestibulo-quadratus to vestibulo-tympanic hearing.

to the quadratus became attenuated as the fascial plaque took up its A.C. function. The muscles receded, the mucosa and skin approximated, until finally the perfected trilaminar drum skin emerged. It is perhaps an oversimplification to speak in terms of these clear-cut transitions and no doubt during the course of evolution various combinations of mechanisms were associated together in a more or less crude form. Nevertheless, the broad principle stands out quite clearly—namely that V.T. was phylogenetically a late development. It was *preceded* by

A. Tumarkin

various combinations of V.Q. and V.H. and the transition from these cruder mechanisms has taken place with widely differing velocities so that among living animals today we find innumerable examples of laggards in various stages of imperfection.

Lastly, we come to the origin of V.O. It seems established beyond reasonable doubt that the mammals evolved out of the primitive stem-

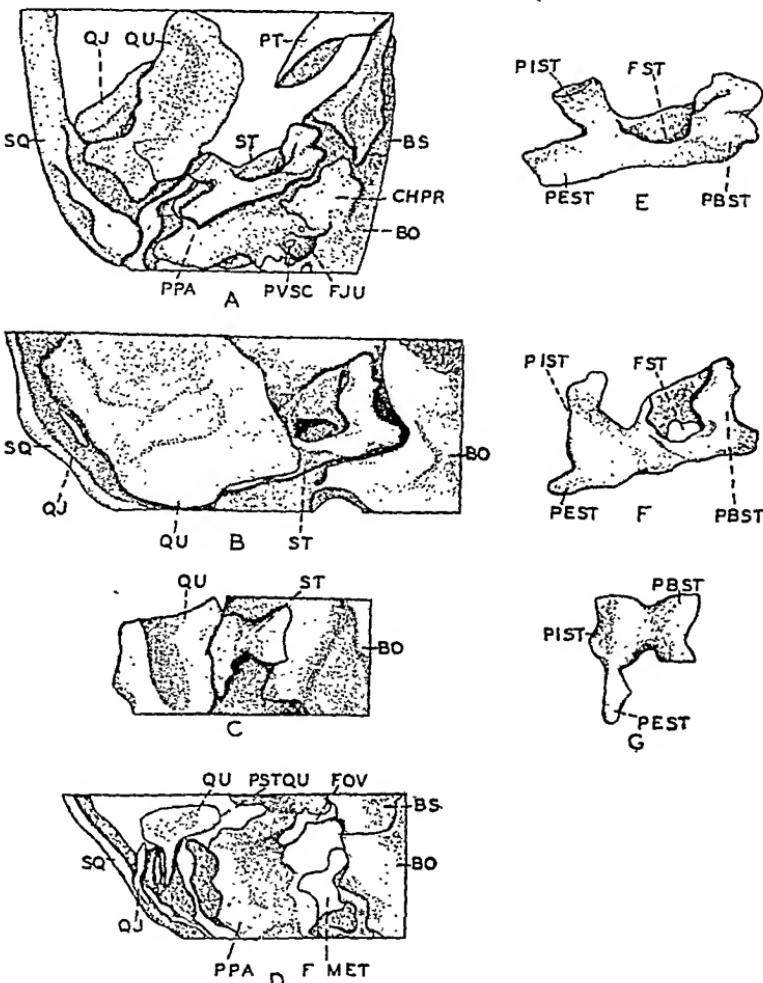


FIG. 10.—The therapsid stapes. Ventral views of right tympanic regions and stapes of selected therapsids. Reconstructed from wax models and from sections. A: Therocephalian B, *Tapinocephalus* zone. B: Gorgonopsian B, *Cistecephalus* zone. C: Anomodont E, *Endothiodon* zone. D: Cynodont B, horizon uncertain. Right stapes of three therapsids in ventral aspect. Drawn from wax models which were reconstructed from sections. E.—Therocephalian B. F.—Gorgonopsian B. G.—Anomodont E.

Note the relatively enormous size of the stapes. In each case the bone is so firmly locked to adjacent bones—especially the quadrate—that a tympanic membrane would have been entirely useless. (From Spec. Papers Geol. Soc. Amer., 1944, No. 55, p. 40, by permission.)

Evolution of Auditory Conducting Apparatus

reptiles (cotylosaurs) first *via* the pelycosaurs and then the therapsids. The pelycosaurs were the dominant reptiles in the Carboniferous era. Subsequently the therapsids flourished in the early Triassic but by the mid-Triassic the therapsids seem to have gone almost extinct, being apparently wiped out by the dinosaurs which flourished all through the Mesozoic era. Fig. 10 shows the stapes of a series of therapsids. In each case the stapes is a massive structure firmly articulating with the adjacent bones, in particular with the quadrate. Efforts have indeed been made to assign a tympanic membrane to these animals but on physical grounds it is manifestly impossible for the feeble flapping of a tympanic membrane to have had the slightest effect on such massive bones. We are obviously dealing with a bone conducting mechanism of V.Q. type. It is interesting to note that side by side with the therapsids were the thecodonts, who were precursors of the dinosaurs. Fig. 11 shows a typical thecodont. The bi-pedal posture and the tiny

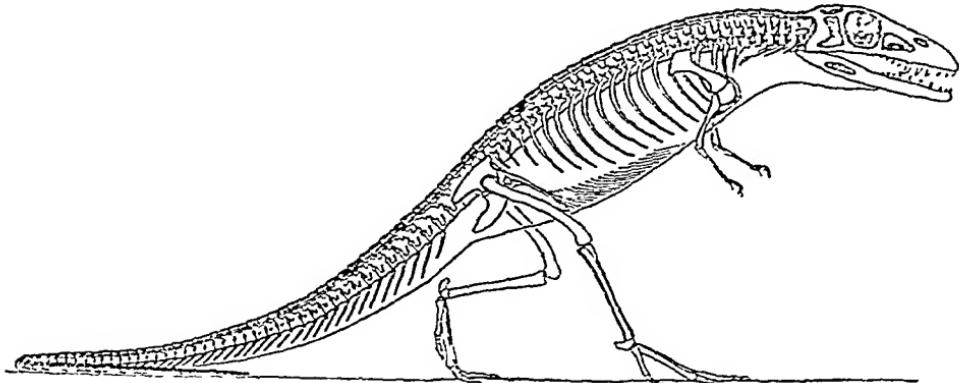


FIG. 11.—*Saltoposuchus*, a lightly built Triassic thecodont, about $3\frac{1}{2}$ ft. in length. (From von Huene.) This animal obviously rarely had its skull or fore-paw on the ground. Therefore it had no use for V.Sq., V.Q. or V.S. hearing. It almost certainly had airborne hearing comparable to that of *Sphenodon*—or it may even have achieved perfect V.T. hearing. (Reproduced by permission.)

fore limbs indicate that this animal could have had no use for V.Sq., V.Q. or V.S. In the writer's opinion it had perfected V.H. and was well on the way to V.T. Evidence for this view will be adduced later, but the point is made here that this acquisition of efficient A.C. hearing by the thecodonts gave them an enormous advantage over the therapsids and probably contributed to the triumph of the dinosaurs and the downfall of the therapsids. It appears that the therapsids survived precariously as tiny inconspicuous omnivores because their descendants, the earliest mammals appeared many millions of years later in the mid-Jurassic with these characteristics. The explanation of the mammalian triple ossicle system is to be found in the amazing metamorphosis of the jaw joint.

A. Tumarkin

We have to consider how the primitive articulo-quadratus joint became supplanted in the mammal by the squamoso-dental joint. The reasons why this change occurred are not clearly understood, but one important factor was the development of powerful masticatory muscles descending from the squamosal to the dentary. In response to functional stress on the bone, outgrowth occurred at these muscle insertions and finally the outgrowth on the dentary reached almost to the squamosal.

Fig. 12 shows the inside of the lower jaw of *Cynognathus*. It still

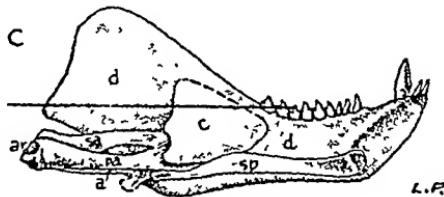


FIG. 12.—Lower jaw of *Cynognathus*—internal aspect
ar—articular. a—angular. d—
dentary sa—surangular pa—pre-articular
(Reproduced by permission)

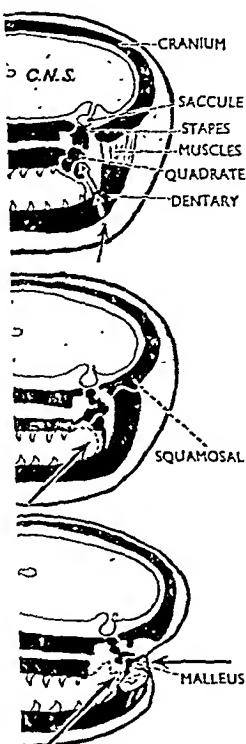
articulates as the articulo-quadratus joint, but obviously the dentary is reaching upwards towards the base of the skull. It is easy to envisage a stage at which a squamosal-dentary bursa would develop externally and superior to the primitive joint. The jaw, in fact rocking on a double articulation. Subsequently, the squamoso-dental joint took over full function and the articulo-quadratus was completely superseded. The subsequent transition may be described in a few words. The ossicles became progressively lighter and at the same time the pharyngeal mucosa pushed outwards whilst the skin pushed inwards. The two layers approximated to form the typical tri-laminate drum. Obviously in the process the articular would be trapped and that explains how the handle of the malleus (which is derived from the articular) persists in the substance of the tympanic membrane. Similarly, the tympanic annulus would develop out of the posterior jaw bone element to which the fibrous tissue in question was attached, i.e., the angular (Fig. 13).

It may be asked why the V.Q. Therapsid stapes did not reach the surface unaided in the same way as the V.Q. stapes of the lizards appears to be doing today. Dabelow has considered this problem in some detail (Ref. 3) and points out that the cranial development of the therapsid was much greater than that of the archosaurs.

In order to accommodate the expanding brain the squamosal bellied outwards and in consequence the oval window sank relatively inwards carrying with it the stapes. Thus the latter was too far from the surface to reach it unaided and so it perforce joined up with the other two ossicles.

Evolution of Auditory Conducting Apparatus

In the writer's opinion, this argument is not well founded, being based on the idea of a tympanic membrane developing on the surface. It seems far more likely that the tympanic membrane was originally laid down as a fibrous plaque under the pharyngeal mucosa and that the pre-mammalian reptiles—just like the earliest archosaurs listened *via* the mouth. Under those circumstances, the vestibulo-mandibular mechanism derived from the obsolescent articulo-quadratus joint provides all that is necessary for the transitional stages from V.Q. to V.O.



The C.N.S. towers above the ear and bellies out external to it. The oval window sinks inwards. The jaw still hinges at the articulo-quadratus joint which has become delicate. Note the massive dentary extending upwards in the muscles towards the squamosal. Vestibulo - quadratus hearing in Cynognathus.

The dentary has reached the squamosal to form the mammalian joint. The reptilian joint is superseded. The ossicles are shrinking in size. The animal opens its mouth to listen.

Vestibulo - mandibular hearing in the earliest mammals.

The ramus of the mandible has been excised to show the ossicles still shrinking in size. The outer ear and the eustachian tube begin to form and as they approximate the articular is trapped in the intervening fibrous layer and becomes the malleus.

FIG. 13.—The development of the triple ossicle system.

At that stage the animal was no longer a reptile, it was a mammal. Its auditory function, however, was still rudimentary as it had only inherited the V.Q. mechanism of its therapsid ancestors. The obsolescence of the articulo-quadratus joint would tend to result in a diminution in size of the associated bones. But that very diminution would make them more and more suitable for acoustic transmission. These hypothetical border-line animals listened through their mouths. We might call this mechanism V.M., i.e., Vestibulo-Mandibular. It is physically closely similar to V.H. In each case the receiving component is the

A. Tumarkin

membranous wall of the bucco-pharynx but whereas the transmitting component in V.H. is the hyoid plus stapes, in V.M. it is the angular plus articular plus quadrate plus stapes. It must be admitted that, in contrast with all the other mechanisms, V.M. is essentially hypothetical, since it has never been demonstrated in any living animal. Most pre-mammalian fossils belong to rather primitive stocks, i.e., they have not advanced very far along the road of evolution, so that they do not show any more convincing evidence of V.M. than does *cynognathus*. Very recently, however, (Ref. 23) Chinese investigators have described fossils which appear to belong to an era much closer to the mammalian horizon, and the accounts so far available do seem to confirm the existence of delicate bones lying freely mobile, underneath the pharyngeal mucosa. These bones may well turn out to be the articulo-quadrate complex, and so provide a dramatic confirmation of the functional theory.

We have now completed our review of the relevant data, and of the two conflicting theories which claim to explain them. We now pass on to a consideration of the relative merits of those two theories. In doing so, the writer is very conscious of the vastness of the subject, and of his own limitations. The main sources of information are gratefully acknowledged in the references, although these represent a mere fraction of the publications which are available. Even so, it may perhaps smack of effrontery for one who has never studied a fossil at first hand to propose a comprehensive theory differing so fundamentally from the orthodox viewpoint. The reader is, however, asked to suspend judgement until he has studied the evidence which will be available in the second half of this paper.

Clinical Aspect of Perceptive Deafness

the electric buzzer with which the note can be varied has been used. It is difficult to prevent a leakage of sound of the tuning fork to the good or unaffected ear. Sound can reach the ear by the open mouth. Masking does not achieve its object and more consistent results are obtained by the patient closing the good ear. Most patients with unilateral deafness complain that they cannot hear in the presence of a loud noise. Somerville Hastings and Scarff discovered that the normal hearing patients and patients suffering from internal ear deafness required a considerable increase in the strength of the signal to hear in the presence of noise. On the other hand, otosclerosis patients with

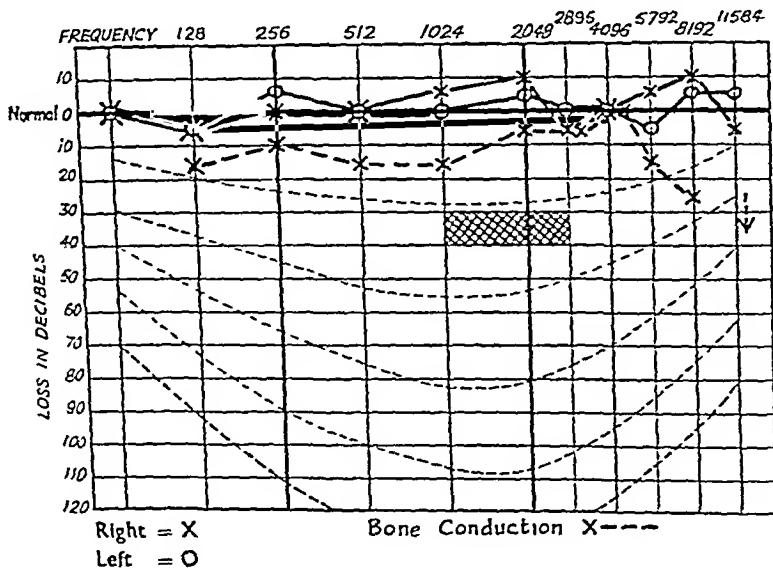


FIG. 1.
Normal hearing.

paracusis do not require as large an increase in the strength of the signal in the presence of noise as do normal patients. Masking by a tuning fork of any vibration even low notes applied by air or bone conduction masks both ears and is therefore inefficient.

Bone conduction tuning fork tests should be carefully and thoroughly carried out. In my experience the Weber lateralizing test, carefully checked and if consistent, is the most reliable when the deafness is unilateral. The audiometer charts may show conclusive differences between a marked middle-ear deafness and perceptive deafness. Bone conduction tests by the audiometer are considered by some observers to be unreliable. The audiogram of normal bone conduction hearing is about 10 decibels lower than that by air conduction (see Fig. 1). The loss of high notes is clearly shown by the audiometer. When total

bilateral deafness is present these tests are all negative and not very helpful. The diagnosis of perceptive deafness is clinched by the exclusion of all other causes of deafness particularly to that due to previous attacks of middle-ear deafness. The cases of mixed middle-ear and internal-ear deafness are the most difficult to diagnose. Perceptive deafness cannot be diagnosed accurately by hearing tests alone. The whole clinical history has to be considered.

The caloric test of the labyrinth is useful. The labyrinthine reaction in cases of cochlear deafness only is normal. All patients suffering from auditory nerve tumour or cerebello-pontine tumours have a coarse spontaneous nystagmus. The nystagmus is more marked when the patient looks towards the side of the tumour, but when the hot and cold caloric tests as carried out by Hallpike and Cawthorne are applied, differences in the nystagmus can be observed though it is very difficult to detect slight modifications of the nystagmus. The Dundas-Grant cold air test is an easy and ready test which I have used for many years in the consulting room. It is simple and easy to apply.

Care should be taken to observe the nystagmus every 15 seconds. A dilatation of the pupil sometimes appears before the nystagmus. The labyrinthine nystagmus is a temporary and fine rotatory tremor of the eyes and is absent except during an attack of vertigo. It is associated with a unilateral lesion of the ears. The spontaneous nystagmus of a cerebellar or cerebello-pontine or auditory nerve tumour and disseminated sclerosis is a coarse lateral nystagmus, more marked when the patient looks towards the lesion. The cold air test is useful in cases of fractures of the skull when a lesion of the internal ear is suspected.

The diagnosis of the site of the lesion in perceptive deafness is often impossible. It is not easy to say definitely that a given case is cochlear or an auditory nerve deafness. For example, the deafness of epidemic cerebrospinal meningitis is caused by a spread of infection along the auditory nerve or the aqueduct of the cochlea. A diffuse suppuration of the whole of the labyrinth and of the organ of Corti has been found. Hagens of Chicago examined 385 children with acquired deafness following cerebrospinal meningitis. 230 children were totally deaf, 155 had some vestiges of hearing. 268 had no vestibular reaction.

It is unusual to obtain a history of injury in many cases of nerve deafness because the internal ear is so well protected by the bony capsule, the perilymph and endolymph. Only a few cases of fracture of the base of the skull in which the fracture has extended into the bony capsule of the labyrinth and the posterior fossa of the skull have survived.

Hogarth Pringle recorded that in his series of 366 undoubted fractures of the skull there were 39 cases of fracture of the posterior fossa seen at the post-mortem examination. All of the posterior fossa fractures died within a short interval after admission to hospital. No patient

Clinical Aspect of Perceptive Deafness

suspected to have a fracture of this type survived. The writer has the notes of 59 cases of fracture of the skull which caused deafness. There were only 6 of them with marked nerve deafness who had survived a fracture which had involved the labyrinth. The remaining 53 had fractures which involved the middle ear only. Hogarth Pringle reports that among his patients there were 8 who had complete and permanent deafness by air and bone conduction. Two had facial paralysis, another patient who died from pneumococcal meningitis on the 23rd day after injury complained of deafness of the right ear. He was completely deaf by air and bone conduction but no other palsy. There was profuse haemorrhage and free discharge of C.S.F. from the right ear. At the post-mortem the auditory nerve was completely severed at the outer limit of the internal meatus. The facial nerve was intact. There are 9 temporal bones at the Ferens Institute obtained from fatal fractures of the skull. The line of fracture had passed through the roof of the eustachian tube, the middle ear, the auditory meatus and mastoid antrum in 7 cases. In the remaining two the fractures had extended across the petrous bone and labyrinth just behind the internal auditory meatus to the jugular fossa. One bone shows blood clot in the internal auditory meatus surrounding the auditory and facial nerves. The auditory meatus and nerves were normal in all the other 8 bones.

Three clinical types of internal-ear deafness arising from head injuries and explosions are recognized :

1. Those with structural and permanent damage to the internal ear. The precise nature of the lesion cannot be determined in all cases.
2. Psychical or Functional deafness.
3. Temporary or Concussion deafness.

Cases of the first group with structural and permanent damage show evidence of severe injury such as bleeding from the ear, the escape of C.S.F., loss of consciousness, paralysis of the cranial nerves especially the facial and other brain injuries. The unexpected has happened in one or two of these cases when the hearing has recovered after a long interval.

The second group of psychical or functional deafness without any visible injury is seen in those who have suffered a severe shock. The patient assumes absolute and bilateral deafness. It is accompanied by other neuropathic symptoms.

The third group consists of cases of temporary or more rarely of slight degree of permanent deafness which are due to concussion, shock or the effect of an explosion or loud noise. These patients frequently recover their hearing. G. Reid states that a single severe trauma with or without rupture of the drums has produced a permanent deafness for high notes in a few patients. A continued repeated noise trauma or concussion has produced a nerve deafness, for example, boilermakers' deafness.

E. D. D. Davis

Labyrinthine lesions have not been observed and when a labyrinthine lesion is present it is difficult to detect, particularly if it is localized. Reid suggests that in permanent concussion deafness there may be a lesion involving the cells of the organ of Corti, a lesion of the basilar membrane or haemorrhage into the internal ear.

Involvement of the hair cells of the organ of Corti has been found in guinea pigs who have been subjected to continuous noise of long duration. J. S. Fraser, Nager and G. Kelemen have described in detail the lesions found in the cochlea when it has been involved in a fracture of the skull. Haemorrhages were seen in the spiral ligament, the lamina spirals and in a few turns of the cochlea the scalae contained masses of blood. One or two turns of the cochlea appeared to have escaped injury. Noise deafness is being prevented by factory inspection and regulations. The protection of ears by wool tampons, the suppression of noise, the elimination of those workers suffering from ear lesions predisposing to noise deafness and other regulations are now adopted. I am indebted to Dr. Sybil Horner, Senior Medical Inspector of Factories who kindly sent me an abstract of these recommendations.

The reception of hearing is very similar to that of the reception of sight. The mechanism of the eyeball, the optic nerve and visual area of the cerebral cortex is analogous to that of the ear but the ophthalmologist has the advantage of being able to see the optic disc with the ophthalmoscope. The otologist can compare the diseases of the internal ear and auditory nerve with those of the eyeball and the optic nerve. For example, it is probable that glaucoma of the internal ear occurs in Ménière's syndrome. Glaucoma is an increased pressure within the eyeball and it is assumed that the increased pressure is produced by obstruction of the venous or lymphatic circulation. Secondary changes occur in the optic nerve and retina, and optic atrophy is common. There are two types of glaucoma of the eye, primary and secondary. Primary glaucoma occurs out of the blue, so to speak and there is no prodromal cause. Secondary glaucoma follows chronic iritis or iridocyclitis and other conditions. The sclerosis of the saccus endolymphaticus discovered by Hallpike in his cases of dilation of the canal of the cochlea suggests a secondary glaucoma of the ear. The variation, the fluctuation and the spontaneous remission for long periods of the symptoms of glaucoma of the eye are similar to those of Ménière's syndrome or aural vertigo. Drainage of the saccus endolymphaticus and the opening of the ampulla of the external semicircular canal has been known to relieve aural vertigo. The difficulty of finding the saccus endolymphaticus is considerable even in the post-mortem temporal bone. Moreover, it is difficult to be sure that the saccus has been opened and not the posterior fossa dura. It is assumed that these operations relieve the pressure of the endolymphatic fluid within the membranous labyrinth. Withdrawal of

Clinical Aspect of Perceptive Deafness

semicircular canal and the bone immersed in a solution of 5 per cent. formalin in saline. A concise clinical history is essential.

I am indebted to the Ferens Institute of Otolaryngology for the use of a well-equipped laboratory and for the opportunities of carrying out clinical investigations.

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CLINICAL RECORD

ASSOCIATED OESOPHAGEAL AND GASTRIC STRICTURES FOLLOWING SWALLOWING OF CAUSTIC SODA

By G. H. CAIGER (Durban)

DURING the last two years I have seen in practice two cases of gastric stricture associated with the common oesophageal type of stricture after ingestion of caustic soda. As I have not seen any reference in the literature to this association, it seems worth recording these two cases, especially as the second case had some unusual features. Also publication may assist in the earlier recognition of similar lesions, and possibly in avoiding unsatisfactory methods of treatment.

Theoretically ingestion of caustic soda may cause not only oesophageal lesions but burns of the gastric mucosa. That this does not occur frequently enough to have acquired general recognition is perhaps surprising. That the oesophageal strictures tend to divert attention from the gastric lesions and mask them is to be expected, and such has been my experience. In each of these patients it has been difficult to persuade other medical men in attendance that the oesophageal stricture was not the cause of persistence of obstructive symptoms. In fact it seems possible that this oesophageal masking has resulted in attributing to the oesophagus pathological effects due to gastric obstruction. This would also result in further unnecessary dilatations of the oesophagus, as happened in the second case below. This masking perchance explains the fact that such gastric complications are not more commonly known, if the lack of literature on the subject is a true criterion.

The frequency of such gastric complication of oesophageal stricture from caustic burn is probably not very great, or in all probability the condition would be more generally recognized.

The assumed low incidence of complicating gastric stricture may be explained on the following grounds:—

1. The caustic may be vomited rapidly.
2. The caustic may be diluted with antidotes of bland fluids subsequently swallowed.
3. The larger surface of the stomach distributes the caustic which is no longer confined in a narrow tube.
4. The gastric mucus and chemical secretions, with possible regurgitation through the pylorus, protect the mucus membranes of the stomach and neutralize the caustic soda.
5. The relatively smaller amount of caustic reaching the stomach compared with the amount contacting the oesophagus.
6. The stomach may be effected but not in sufficient degree to cause actual obstruction in a larger spaced cavity, the resulting scar not being a cause of mechanical block.

Clinical Record

7. A further reason for a gastric stricture escaping detection is the fact that it has not been suspected and specifically sought on X-ray examination, and secondly that the quantity of opaque medium reaching the stomach through the strictured oesophagus is insufficient to demonstrate the obstruction. There may be a time lag before a gastric stricture develops and opaque medium examination may be carried out before contracture has produced a stricture, and gastric appearances are normal. This would confirm belief that no lesion existed below the oesophagus. It may be that the formation of a stricture in a narrow tube like the oesophagus is a more rapid process than in the wider gastric cavity.

Case I.

A Zulu woman was admitted to the McCord Zulu Hospital (Mission) about two years ago for difficulty in swallowing, following the ingestion of caustic soda some time previously. (I have no notes of this case but the facts here given are correct so far as I know.)

An oesophagoscopy for dilatation of the "Stricture" was carried out by me, and sounds up to No. 15 French were easily passed through the only section offering any obstruction at the cardiac end of the oesophagus. About four weeks later I was asked to dilate the stricture again as she still had difficulty in "swallowing". On this occasion I passed easily straight away a No. 15 bougie, and formed the impression that there was not sufficient obstruction in any part of the oesophagus to cause difficulty in swallowing.

I felt that the ingestion of caustic soda was causing the oesophagus to be blamed for symptoms which did not appear on review to be justified. I therefore advised that an X-ray of the stomach with opaque medium should be carried out. As a result of this examination an obstruction of the pyloric end of the stomach was shown. Gastro-enterostomy was subsequently performed. As far as I know the patient had no further trouble.

(It is possible that this patient had not swallowed caustic soda, but it is unlikely that this type of patient would have made such a misleading statement, and she probably had done so.)

After the first "dilatation" I had cast doubt on the diagnosis of "oesophageal stricture" but it was not till a second dilatation had been attempted that this carried conviction.

Case II.

A European woman aet 28, of slender build and mother of three children, on 18.1.46 accidentally swallowed caustic soda. Three weeks later gastrostomy was performed at an inland hospital.

11.5.46 she arrived in Hospital locally where she had been transferred with gastrostomy tube in situ, through which she was being fed.

Dilatation of the stricture (oesophageal) was carried out on the date recorded below and the maximum size of bougie passed on each occasion noted:—

- 17.5.46. Bougie passed No. 17 French.
- 27.5.46. Bougie passed No. 22 French (? inaccurate record).
- 7.6.46. Bougie passed No. 16 French.
- 14.6.46. Bougie passed No. 16 French.
- 21.6.46. Bougie passed No. 17 French.

G. H. Caiger

28.6.46. Bougie passed No. 15 French.

12.7.46. Bougie passed No. 15 French.

25.7.46. Bougie passed No. 16 French.

Easy dilatation to the above size bougie was effected each time. I had difficulty in persuading my Assistant in the Department that I did not believe the oesophagus was the true cause of her disability, and she was brought to the theatre for dilatation at least twice after I had suggested that an X-ray examination by opaque medium of the oesophagus and stomach should be done. I had then had the first case which had shown a gastric obstruction (pyloric). It is not usual for a patient on whom a No. 15 French bougie can be passed to suffer much disability in swallowing selected foods.

Radiological Report :

"Barium meal passes into the stomach but it is retained for 24 hours before commencing to pass into the jejunum. Pyloric stricture?"

The patient was transferred to a Surgical Department.

The following is the House Surgeon's report at the time (note how the report appears to be influenced by the history of the swallowing of the caustic soda) :—

"She is quite unable to take anything by mouth and now even saliva cannot be swallowed. Gastrostomy feeds are retained quite well and are never followed by vomiting. It is felt that the cause of the difficulty in eating lies below the oesophagus and a surgical opinion is requested." "Liver therapy started and a high protein and vitamin diet."

28.8.46. Operation of gastrectomy performed through left paramedian incision. Extensive adhesions of omentum encountered and a large organized blood clot just medial to the gastrostomy tube. Landmarks difficult to define. Jejunum freely mobile. Stomach very contracted and with what at first appeared to be a duodenostomy. This was freed from the parietes and closed by purse-strings suture, to disclose an hour-glass constriction of the stomach with a gastrostomy below the scar. The stomach on the whole was very gnarled and deformed. Pylorus transected and duodenal stump closed. Stomach dissected and mobilized to above the constriction and diseased portion removed. The stump of the stomach anastomized to the duodenum which was dilated and freely movable. Bleeding points ligated and abdomen closed."

After the operation the patient returned home, but was not seen by the E.N.T. Department and unfortunately no opaque medium examination was carried out.

12.1.47 she was admitted under the E.N.T. Department unable to swallow, very wasted and weighing about 80 lbs. This was four and a half months after her gastric operation.

Oesophageal dilatations were carried out on dates below and the maximum size of bougie passed are recorded again :—

20.1.47. Bougie not recorded.

7.3.47. Bougie not recorded.

6.6.47. Bougie 8.

4.7.47. Bougie 5 passed easily, 6 with difficulty, and 7 would not pass what was thought to be the cardia.

Clinical Record

- 8.7.47. Bougie 5 passed, 6 would not pass the " cardia ".
5.8.47. Bougie 9 passed. Had not been able to take " even fluids " for three days.
4.10.47. Bougie 5 passed. (Says she has put on a little weight.)
7.11.47. Bougie 5 would not pass " cardia ".
5.12.47. Bougie 5 would not pass.
8.1.48. Bougie 9 said to have passed.
6.2.48. Bougie not recorded.
9.2.48. Bougie 5 passed.

(I cannot but be doubtful if the size 9 recorded as passed on 8.1.48 is a correct record. Numbers are difficult to read and become blurred with time and use, and the nurse or H.S. may easily be mistaken. It would be of help if the manufacturer could stamp the number on a small metal band at the lower end of the bougie where it would remain clearer with the passage of time. With the smaller bougies the space for the number is very limited. Metal at the thick end should not be of moment in the essential use of the bougie.)

The patient was referred to the Surgeon for his opinion and he advised sending her home.

At this stage the difference in the state of the oesophagus from the pre-gastrectomy condition when No. 15 bougies were passed easily is notable. I formed the impression that this was due in the main to two probable factors, one the increased tension on the oesophagus from the traction due to the shortened stomach or what remained of it, and two the " angulation " at the " cardia " from the attachment of the remaining shortened stomach to the duodenum.

The stricture of the oesophagus did not appear likely after the interval since last dilated, to be accounted for by further contraction from the original burn. Little evidence of increasing contracture was shown from a study of the size bougies passed at pre-operative dilatations as the size remained about 15 French.

The marked change in the oesophagus where even the smallest bougies passed were firmly gripped now, as never before operation, was striking. And this has persisted up to the present. In general the patient did not seem to have benefited by the gastric operation at this stage. Her ability to take nourishment was not so good as it was before with only a moderate oesophageal obstruction plus an hour-glass stomach. At this period her condition was a cause for grave anxiety as she could take little if anything *via* the oesophagus and relief by further gastrostomy was problematical. Fortunately she was able to swallow enough fluid to sustain life. From this stage she improved slowly. Ingestion of more fluid became possible with the passage of time. I thought that this might be due to diminished traction on the lower end of the oesophagus through gradual stretching of the remaining stomach, assuming that diminished traction would allow increase in size of the lumen (oesophageal). A slight increase of weight took place.

The experience with the second case of this dual type of stricture raises the question of the suitability of the surgical technique for dealing with the gastric lesion. An excellent technique for dealing with the gastric condition may be unsuitable where there is concomitant oesophageal stricture. This was the

impression I formed from the second case. In such cases it would appear undesirable to sacrifice any gastric tissue that can be conserved. Possible secondary effects on the strictured œsophagus must be borne in mind, where a fibrous stricture of indefinite length may be present which has a much diminished elasticity. The effect of undue traction on such an œsophagus must be to diminish the size of the lumen in extending the length of the tube. Where the tube is strictured by the fibrosis resulting from a caustic burn little hope of dilatation to overcome the effects of traction can be justified. The tube has already been dilated previously to the maximum safety suggests, and further dilatation may be fraught with danger.

A second effect of the sacrifice of gastric tissue is to produce a change in the axial direction between the cardia and the pylorus along which food flows after traversing the œsophagus. This probably results in angulation at the cardia. Where there is tension on the lower end of the œsophagus this further factor of angulation or bending may restrict the lumen. My impression in Case II was that it was such "angulation" with tension that caused the main obstruction to the passage of bougies in the attempt to dilate the lumen. As No. 15 Bougie could be passed repeatedly pre-operatively, it seems probable that it was at this cardiac site that the block occurred and measurement of the distance to the obstruction confirmed it, judging by external rough measurement at dilatation. There may also be some element of valvular action by apposition of the walls of the gut at the site of angulation.

When such dual œsophageal and gastric lesions are present it is highly desirable that close co-operation between the œsophagoscopist and surgeon is ensured before gastric surgery is carried out. The exceptional nature of these lesions should be borne in mind and emphasis placed on need for conservative techniques to meet the special circumstances.

SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY
WITH SECTION OF OTOTOLOGY

COMBINED SUMMER MEETING HELD IN BRISTOL
LARYNGOLOGICAL SESSION

July 2nd, 1948

Chairman—A. J. WRIGHT, F.R.C.S. (*President of the Section of Laryngology*)

Recent Progress in Nasal Physiology

By ARTHUR W. PROETZ (St. Louis, U.S.A.)

At first thought I had intended to pick up the thread where I had left it in a presentation before this Society in 1938 (*Proc. roy. Soc. med.*, xxxi, 1405) and to bring it up to date by reviewing the literature of the decade. It quickly appeared that such a report would be misleading since progress during this time has, in some phases, rested much more upon older investigations than upon current ones. A few titles of articles appearing since 1938 have been appended. From these it will be seen that research on nasal physiology is still restricted and, as usual, highly specialized.

Before our day, interest was sometimes concentrated upon special investigations such as Braune and Clasen's work on nasal air pressures (1876) and Zwaardemaker's practical treatise on the physiology of smell (1895), but all this seemed fairly remote from clinical rhinology and very little effort was made to bring it closer. Probably the germ from which sprang our present interest was an article written by an Englishman in 1924: "Methods of Estimating the Activity of the Ciliated Epithelium Within the Sinuses", by A. Lowndes Yates. It somehow fired the imagination of investigators in this country and in America and led to a recrudescence of interest in the whole subject of nasal physiology. Co-ordination followed and finally the more systematic application of physiological principles to a none too satisfactory therapy.

It has been reiterated in the textbooks, in a detached way, that the nose moistened and heated the air for the lungs and that it was coated with a ciliated columnar epithelium. In practice, however, physiological processes were treated as something academic, which could be disregarded when the problem was one of eradicating infection. Emphasis was laid upon the "vestigial" character of the nasal structures. Since their importance in maintaining nasal health was not understood it cannot be said that they were wilfully disregarded but the unsatisfactory results of radical exenteration finally forced us to examine them more closely.

To-day we have learned to conserve tissues and functions wherever possible

Societies' Proceedings

Whenever this question of conservation is introduced someone invariably cites cases in which conservation would be folly. I also have such cases. However, these are the exception and we have found it practical to suit our procedures to the requirements and not invariably to go the limit on the mere basis of supposed thoroughness.

Among the trends of the past decade the appreciation of ciliary activity in the nose and especially in the accessory sinuses undoubtedly is first in importance. Cilia are primitive structures surviving anything which does not destroy epithelium. They are powerful in their effect and they behave in an orderly manner. They are our best allies in the prevention and removal of infection and they cannot be indiscriminately done away with if nasal health is to be maintained. The fact that in the average adult nose there are areas of altered mucosa without cilia—and this without producing untoward symptoms—may have led us to underestimate them. Patches of pseudo-squamous epithelium result where the air can strike directly and for this reason they are either dry or accessible to blowing. But in the meatuses about the ostia, and certainly in the sinuses where this is impossible, cilia persist and it is desirable to maintain the continuity of streaming from sinus to ostium, to meatus, to nasopharynx as well as may be. Wherever disease or surgery results in a strip of non-ciliated epithelium in the path of the streaming there is a stasis of the mucus and conditions favourable to bacterial growth are set up. This is not always apparent on inspection for the normal mucus blanket is of microscopic thinness. The mucus is of such nature and of such minute quantity that unless it is augmented by exudates and the degenerative products of inflammation it cannot be seen. With a microscope and by other special means it can be demonstrated and in proportion to the size of the bacterial elements picked up it is completely adequate.

We were taught a generation ago, and with seeming logic, that removing a middle turbinate did not reduce the moistening surface of the nose so very much and that it could be sacrificed in the interests of drainage with relative impunity. To a great extent this is true owing to a circumstance not considered at the time, namely, that the middle turbinates are streamlined to the passing air currents. Thus, although the moistening surface is reduced, there is little interference with the distribution of inspired air. Minor changes of another type may be followed by distressing consequences. This occurs when the air stream is so obstructed or deviated as to project it in a concentrated jet against some restricted area or to deflect it away from some part of the nose, leaving an area unventilated.

As long ago as 1830 Bell described the constriction which exists approximately one centimetre proximal to the naris. Only recently was it pointed out that this constriction projected the initial air stream vertically, setting the pattern for its even distribution through the nose and being largely responsible for the prevention of local dry spots. Thus our predecessors, regarding the removal of nasal tissue wholly from the standpoint of its moistening function alone, did not hesitate to remove it extensively. We think of it now as upsetting the even distribution of air with its attendant mucus stasis and nasal infection.

We know also that the total moisture reaching the lung is not too dependent

Royal Society of Medicine

upon the retention of the nasal structures. It has been shown that breathing through the mouth supplies practically the same humidity at the glottis as breathing through the nose, with the important difference that the mouth soon dries while the nasal mucosa continues to supply moisture. There is one mechanical circumstance, however, which is commonly overlooked, namely, that the air channels are not a tube at all and certainly not a chamber but a series of extremely narrow slits by which arrangement all the inspired air is brought into intimate contact with the nasal surfaces. If we alter this condition the mechanics of nasal respiration are greatly upset.

That the nose is a filter has been known as long as anyone has paid attention to such things. "The nares," writes Cicero, "which are always open on account of necessary functions have narrower entrances lest anything which might be injurious should enter them, and they always are supplied with a moisture not useless for arresting dust and many other things." We know that this takes place through sifting, through impingement and through adsorption. It is axiomatic that a filter must be rid of the residue which accumulates upon it if it is to continue to function. This the nose does very well by means of the cilia and their mucus blanket. So long as these remain intact, infection cannot occur, largely for the reason that at the normal rate of progress bacteria which fall on the surface are carried past any given cell in something less than 1-10th second, a time too short for incubation and penetration.¹² What the effect of viruses may be in disrupting this system is as yet not clear.

Nevertheless we are confronted with the fact that all infectious ailments of the nose stem somehow from a single source, namely, the failure of the filter to cleanse itself. That this cleansing mechanism should have first consideration in every plan of treatment and surgery is only an extension of the old principle of maintaining drainage.

It has been shown experimentally that removing strips of mucosa within the sinus is not always followed by complete regeneration and results sometimes in fibrous septa, their extent depending in a general way on the width of the strip removed. Entering a sinus surgically by enlarging its ostium is comparable to these experiments. It results in a denuded strip of injured bone and the tissue which forms in Nature's attempt to close the opening resembles the experimental fibrous septum and not the normal ostium.

Drainage artificially maintained by displacement over a period of time is preferable to instrumentation of any kind, since it maintains the continuity of ciliary activity.

In 1943 Hilding made a significant contribution to the controversial subject of negative pressure in the sinuses and more especially of its origin.⁵ He introduced a needle into each of the frontal sinuses of a dog through the skull and connected them through tubes with separate manometers. A quantity of mucus was injected through another needle into one sinus, the other being used as a control. As the mucus was forced out through the ostium by the cilia the pressure began to fall in the manometer of that side, the other remaining stationary. The experiment was then repeated after killing the dog, to rule out possible air absorption. The results were the same except that the negative pressure was slightly less than in the living animal. The published graphs show a drop of 44mm. of water in fifteen minutes in the dead animal. This

Societies' Proceedings

is a negative pressure comparable to that produced by a violent sniff (50mm. Braune and Clasen).

Ciliary streaming within a sinus does not approach the ostium in a haphazard pattern but assumes a roughly vortical character, the direction of whorl being opposite on the two sides.⁶ This is of interest in view of a similar observation regarding the trachea and bronchi by Barclay, Franklin and Macbeth (1937, *J. Physiol.*, xc, 347).

It has been observed that stimulation of the intact vagus in dogs causes a vigorous constriction in the nose with a drop in nasal air pressures without affecting the general circulation as evidenced by the femoral blood-pressure.⁸ Injection of histamine into the circulation causes a dilatation of the nasal vessels, but the effect in this case is general although there seems to be a certain specificity for the nasal vessels. Sympathetic activity is said to predominate following exposure to cold.

The absorptive capacity of the nasal mucosa is variable.¹⁰ Any increase in blood and lymph circulation whether produced by physical or pathological agents increases absorption. The ease with which absorbable drugs are taken up by the sinus mucosa after displacement depends upon the viscosity. The absorption is apparently somewhat selective.

Protracted exposure to toxins of infection stops the activity first of mucous and then of serous glands.¹

The subject of lysozyme in the nasal secretions still appears sporadically in the literature. It is reported¹³ that the lysis of test bacteria by nasal mucus is inhibited by acid concentrations which may be present "in the usual pH swings". In acid media adsorption takes place but no lysis. Change to a neutral reaction completes the cycle, but the bacteria may already have been killed by the adsorption, without being dissolved. The same author states that lysozyme disappears on the first or second day of a cold, and that there is none to be found in a "running nose". Secretions from hay-fever sufferers showed a high lysozyme content.

Some controversy still exists regarding the normal pH of the nasal mucosa. It seems likely that the figure closely approximates 7 under varying conditions and that the disparity in findings of various investigators is due to technical errors and the shifting reactions of the secretions on the surface.^{16 17}

It has been shown clinically that deficiency of the thyroid hormone may result in changes in the nasal mucosa which can be recognized.²⁵ These changes may be either exfoliative in nature or resemble the pale, boggy manifestations of allergy. Patients deficient in the thyroid hormone commonly have an increased tendency to nasal infection which can be corrected by the administration of thyroid extract alone. Similarly, allergic individuals are less apt to exhibit nasal symptoms under an adequate thyroid supply.

The use of the extract and the dosage are best determined by the patient's response, the basal metabolic rate is of secondary importance and at times misleading.

This finding is in line with what is known of the general tissue reactions to deficiencies in the thyroid hormone. The symptoms arising in the nose which respond to thyroid administration, namely, extravasation, changes in the nature of the surface fluids, permeability, malnutrition, swelling and oedema, could

Royal Society of Medicine

logically result from these reactions. Any of them would render the mucosa more susceptible to infection and possibly to antigens as well.

This by no means touches upon all the individual observations in nasal physiology during the last ten years but it epitomizes those which are apt to have an influence on our clinical management of nasal disease.

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GENERAL

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GÖSTA DOHLMAN (Lund, Sweden) asked whether the experiments with soluble dye were made on the living animal or on the preparation. He had put fluorescent particles in the nose and had not been able to observe that these soluble particles dyed the mucous membrane. This could be seen under ultra-violet light. He used fluorescent solution, which was carried away with the mucous blanket. He had tried to observe the same thing with pollen in hay fever, but he had not been able to trace what happened to the pollen. He wondered whether Dr. Proetz, working on these lines, had thought of the mechanism of action of the pollen as comparable with a soluble dye or a virus. Or was there some activity in the pollen particles themselves? Was there something in the action of the pollen, working itself down to the cell, which was likely to cause the allergic reaction or could the activity be compared with that of a virus or infectious agent in a watery solution?

R. G. MACBETH referred to the spiral movement of particles in the trachea. What did Dr. Proetz think was the explanation of this movement? If the particles did not go up in a spiral a certain number of them would reach the carinae at every bifurcation in the bronchial tree and tend to stick or to fall back again; but, in a spiral movement, there was greater likelihood that they would dodge the carinae and so reach the pharynx.

F. A. PICKWORTH asked what was the proportion of surface to blood-stream and lymphatic infections of the nasal sinus membrane. Professor Proetz had confined his remarks to surface infection, and the literature was vague on this question, except that it was established that in the specific infectious fevers the sinus membrane is always involved.

A point of interest concerning the cilia was their collective force. Sir Leonard Hill had shown that small brass weights were propelled along an excised strip of mucosa by ciliary activity. In numerous cases of histological sections of pus or mucopus *in situ* in a nasal sinus taken at autopsies on mental hospital patients, the mass had formed a ball which evidently had been turned round

Royal Society of Medicine

many times, so that there were layers—as indicated by the polymorphonuclear leucocytes—sometimes amounting to twelve or more.

A. W. PROETZ, in reply to several questions, said that regeneration of the mucosa did take place in the right milieu. It was necessary to keep the surface as free as possible from the infectious material which accumulated in the viscous secretions. He used the displacement method in order to get the required vasoconstriction in the cells. This, since the solutions were retained for twelve or fifteen hours, got rid of the irritating substances on the surface. The next thing was to get the surroundings as moist as possible, especially during the hours of sleep. It was arranged that the nose should be in as nearly a physiological condition as possible by maintaining normal moisture and heat and keeping it perfectly free. If sticky mucus were left on the surface its presence was always an irritation.

The other thing which he used was a simple solution which he had found very useful—4 per cent. alcohol and 4 per cent. glycerin in normal saline. It was found a few years ago that the membrane could tolerate about 18 per cent. alcohol, so one was within very comfortable limits in using 4 per cent. What he wanted to do was to have something which would stimulate the flow of mucus and then promptly get itself out of the way so that it would not be a constant source of irritation. Therefore they started with 4 per cent. alcohol. It stung mildly and then evaporated and disappeared, and the glycerin left behind held the moisture. If the patient were laid down and his head placed back it was slightly painful; he should be allowed to sit up and the solution be put over his turbinates. The action of this solution is the opposite to that of ephedrine. It was used every four hours for two or three days, and the nose was then given a chance to take care of itself. The blood came from small vessels into the mucosa, and he did not see why that should not be the path of the bacteria as well. He illustrated how the converging streams of mucus came along and the appearance of the section layer on layer.

On the question of spirals, he thought the theory of the Archimedean screw would be all right if the column of air were always upright, but in fact it was horizontal during sleep for eight hours of the night, and, moreover, it varied in different positions, being sometimes more uphill than at others. The drainage of the sphenoid was not entirely uphill; some of it was and some of it was downhill. He had the feeling that this was a developmental matter. In the trachea, considering the adjustment of the whole thing, he imagined that it would be better if the fibres were spiral than if they were longitudinal. He did not know about the accumulation of mucus at the carinae.

Apparently a small amount of injury of the nasal mucosa did not appear to make much difference. Numbers of people had considerable areas in the nose which were devoid of cilia altogether, and they got along just as well as other people. If the mucosa was anything like normal the cilia around the edge of an inactive area could pull the stream along for quite a distance, so that the inactive area did not really signify. There were no cilia in the pre-turbinate area, and yet the cilia at the margin were strong enough to carry the whole mucus right across the surface. If therefore the ciliated area were destroyed here and there it did not seem to make much difference, though if the destruction was at an important spot, of course, there was trouble.

Societies' Proceedings

In reply to a question on air circulation in the nose and the nasopharynx, this was checked by taking a section of a specimen head, not too emaciated, and pinching it between two plates of glass, then passing a current of smoke-laden air through the nose and taking motion pictures. It was found that a vertical rush of air was an invariable result ; the air then spread out in various forms of eddies. A point which worried him was that he was not sure that the eddies were not to be considered in relation to the distribution of air in the back of the nose. There was a certain fallacy attaching to a model viewed through a glass plate. The septum was not the equivalent of a straight glass plate. His anatomist and he were trying to work out some nasal reconstruction by means of plastic in such a way that they could get a true representation of the nose, but they had to admit that noses, like other parts of the anatomy, varied, and this was a long job, and he did not know yet the answer. Comparative anatomy could be studied to any extent. The functions of the sinuses, for example, differed very greatly. In some lower animals, such as the seal, there were no sinuses. He had an idea that the sinuses might be insulatory in their nature. The giraffe, for instance, had a brain about as big as one's fist, and all the rest was sinuses—an air jacket.

He had no particular experience of the phase of the subject which Dr. Dohlman had developed. He had wanted to make it clear that he was not so much concerned with the infection of the cells and whether they could be stained as he was to try to work out some means by which an invading mechanism could stay in contact with one cell surface long enough to infect. If the substance was soluble it could spread over enough of the surface as it moved along to affect the viscosity of the mucous blanket and so make it ineffective. A slight variation in the mucus content had a great effect on the viscosity. If a soluble substance could bring that viscosity down to a point where the mucous blanket could no longer be pulled over the surface, like a tablecloth over a table, an opening was afforded for infection. This was admittedly theoretical.

As to the nature of the ciliary movement, nobody knew why it took that particular pattern nor what caused it. He had tried ways of getting enough magnification of the cilia to see whether they had any structure that would give an indication as to what made them move. The cilia were difficult to study and to photograph ; they were packed closely and were highly refractile. It was like taking a photograph of a plastic hair-brush while the bristles were moving at 10 to 15 cycles a second. Sodium light had been used, also polarization ; the stroboscope and the high-speed flash had been employed, but no structure could be seen in the cilium. It was the deduction of Seo (1931, *Jap. J. med. Sc. Tr. III, Biophys.*, ii, 47) that the movement was nervous. Various experiments had been made, but the result was hard to evaluate. It might be a chemical stimulation due to potassium secreted at the end of a nerve. The subject was an open one.

The Nasal Mucous Membrane in Relation to the Lymph Stream and Cerebrospinal Fluid

By J. M. YOFFEY

THE nose in mammals possesses a rich submucous lymphatic plexus, which drains finally into the deep cervical duct or jugular lymph trunk. The deep

Royal Society of Medicine

cervical duct descends alongside the internal jugular vein to enter the thoracic duct on the left side, and the right lymph duct on the right. The deep cervical duct passes in most mammals through one large lymph node, but in monkeys and man the single large node is replaced by several smaller ones, strung along the course of the duct to give a characteristic appearance. Submucous lymphatic plexus, collecting vessels, cervical lymph node or nodes, and deep cervical duct together constitute a single functional pathway for the flow of lymph, mainly from the nose, but to a lesser extent from the mouth, pharynx and deep structures of the neck. We have called this the deep cervical pathway.

The deep cervical pathway can be clearly demonstrated as a functioning unit by the nasal instillation of a vital dye, as shown by Yoffey and Drinker (1938, *J. Exp. Med.*, lxviii, 629). The dye passes through the intact mucous membrane, enters the submucous lymphatics, and passes through the lymph node or nodes and the cervical duct to reach the blood. On subsequent dissection the pathway stands out very sharply—almost diagrammatically—and is deeply coloured by the dye. The more functional aspect of the pathway can best be shown if the cervical duct is first cannulated, and clear lymph obtained, and then dye introduced into the nose. It is only a matter of minutes before dye begins to appear in the cannula in gradually increasing concentration.

Not only dyes, but also proteins of low molecular weight, such as egg albumin with a weight of about 34,000, can readily pass through the living and intact nasal mucosa and be identified in the lymph of the cervical pathway, which shares with lymph elsewhere the fundamental property of collecting extravascular protein and returning it to the blood. The significance of absorption from the nasal mucosa of particles up to the size of egg albumin, and even serum albumin (mol. wt. = c. 70,000) need hardly be stressed. Though the actual amount of matter absorbed is not large, substances to which the organism has become hypersensitive can evoke a vigorous response in quite small quantities. Many of the allergic conditions of the nasal mucosa could no doubt be accounted for in some such manner. Bacterial antibodies are usually globulins with a molecular weight of about 180,000, and are too large to pass through the nasal mucosa. Toxins are a good deal smaller, and since a slight amount of toxin can stimulate considerable antibody formation, the introduction of toxin (e.g. diphtheria) into the nose has been used as a means of securing immunity.

Particulate matter such as India ink does not traverse the mucous membrane after nasal instillation, nor do viruses, in a susceptible animal, pass through the nasal mucosa immediately. However, after a period in which they proliferate locally and become established in the mucous membrane, they then enter the cervical pathway and reach the blood in a steady and continuous stream. Working with rabbits, Yoffey and Sullivan (1940, *J. Exp. Med.*, lxix, 133) showed that vaccinia virus was not merely not prevented from reaching the blood-stream by the filtering action of the cervical lymph node, but that on the contrary lymph nodes form a perfect mechanism for the dissemination of virus. The cytotropic virus particles enter the lymphocytes which are constantly leaving the node, and the lymphocytes thus act as virus carriers which protect

Societies' Proceedings

the virus while in the blood-stream, and enable it to reach any part of the body.

What is the exact origin of the lymph in the cervical pathway? In part it arises in the usual manner, from the capillary filtrate of the submucous blood-vessels. But it also seems certain that some of the cervical lymph is derived from the cerebrospinal fluid, leaving the skull through the cribriform plate in association with the emerging bundles of the olfactory nerve. It has been generally accepted that if care is taken not to exceed the normal pressure of the cerebrospinal fluid, simple crystalloids injected into the cranial subarachnoid space readily pass through the cribriform plate and reach the nose, while particulate matter on the other hand does not. Statements about particulate matter are difficult to assess unless one knows the size of the particles, an item of information which has been conspicuous in the literature by its absence. Recently Field, Brierley and Yoffey (1948, unpublished), studying sections through the cribriform plate, after injecting into the cranial subarachnoid space at physiological pressures a suspension of India ink whose particles ranged in size from $0.5\ \mu$ to $1.5\ \mu$, found that the ink particles passed freely along the course of the olfactory nerve bundles, both around the bundles, and in their substance, to their termination in the olfactory mucous membrane. Here the sub-epineurial spaces containing the ink ended in the immediate vicinity of the submucous lymph vessels. There must therefore normally be a steady flow of cerebrospinal fluid through the cribriform plate into the nasal lymphatics, and possibly also through the nasal mucous membrane to the nasal cavity.

This centripetal flow must be sufficiently vigorous to transport ink particles, but as yet we have no way of measuring it quantitatively. It is interesting to note that in the monkey there is usually a steady spontaneous flow of cervical lymph, whereas in the cat and dog such a flow is exceptional. The occurrence of this spontaneous flow in a microsomatic animal such as the monkey—and presumably man—is possibly due to the increased volume of the brain and cerebrospinal fluid.

If bacteria and viruses behaved as inert ink particles, no infection of the nose would be likely to reach the brain, against the current of cerebrospinal fluid. On the other hand bacteria or viruses which obtained access to the cerebrospinal fluid—e.g. in meningitis—would certainly reach the nasal mucous membrane and the cervical pathway; and while viruses would find no difficulty in traversing this pathway, for the reasons already noted, bacteria would be held up in the uppermost node or two of the chain. But since bacteria and viruses are not merely inert particles, but can spread by active growth, new possibilities of extension are thereby created as in the possible neurotropic spread of a virus such as that of poliomyelitis.

A. W. PROETZ said that it had been noticed clinically in certain patients that they had an irritative process beginning in the nasopharynx and going downwards, so that within thirty-six hours the patient was left without a voice. Was there any evidence from any of these specimens that materials could pass down immediately below the surface in the lymphatics? Clinically there was evidence that it did. It was such a continuous process that one could almost predict when it would reach the larynx and then the trachea.

Royal Society of Medicine

F. A. PICKWORTH had done experiments with human material on cerebrospinal fluid pathways using the ferrocyanide technique, and had published a figure (*Z. ges. Neurol. Psychiat.*, 1932, cxli, 425) where the dye had passed along the maxillary nerve and had formed a collection in the antrum which contained pus, had a thickened membrane, and local haemorrhages. The antrum of the other side was normal and the nerve showed no passage of the dye. Professor Yoffey had illustrated the passage of sizeable particles along the cerebrospinal pathways to the nasal mucosa in a rabbit suffering from "snuffles"; had he any other evidence of increased cerebrospinal flow into the tissues in diseased conditions affecting the nerve sheaths?

J. M. YOFFEY, in reply to several speakers, said that he found difficulty in answering some of the clinical questions. Unless results were checked and rechecked on the experimental animal they could not make a dogmatic statement about pathways of lymphatic spread. In experiments on the main cervical pathway, outlined after nasal instillation of dye, communications with parapharyngeal and paratracheal lymphatics were not infrequently seen, but they were not so well-filled with dye as the main cervical pathway, along which lymph from the nose normally flowed most readily. However, if the main cervical pathway were to be obstructed, these collateral sources of lymph flow, which undoubtedly existed, extended right down to the lower end of the trachea, and could presumably account for some of the clinical observations on the paratracheal spread of infection. The classical method of interstitial injection of lymphatics in the dead animal merely showed injection material spreading in all directions from the site of injection, and gave no idea of the direction taken by lymph in the living functioning pathway.

With regard to the lymphatic vessels of the tonsils, he had nothing further to add to what he had already said, namely that in the experiments described peritonsillar lymph vessels were always evident, but not vessels arising directly from the tonsillar tissue. According to Aschoff's original classification of the lymphatic organs, the tonsils possessed efferent but not afferent lymphatics. If these efferent lymphatics existed in appreciable numbers, the larger peritonsillar lymphatics would represent the collecting vessels into which they drained.

With regard to Dr. Pickworth's question the ferrocyanide technique, unless employed with scrupulous care, was open to the objection that the solution may diffuse quite rapidly through the tissues, even through the substance of bones, and therefore may not be too reliable an indicator of normal fluid pathways. Nevertheless it was highly probable that the sheaths of the other cranial nerves possessed the same properties as those of the olfactory nerves though to a lesser extent. Schwalbe among the earlier workers reported the escape of India ink from the cranium along the nerves of the jugular foramen, and there seemed no reason why, under abnormal conditions, other cranial nerves besides would not also permit the perineural spread of crystalloid or particulate matter. The speaker had no direct evidence of increased cerebrospinal fluid flow into the tissues in diseased conditions affecting the nerve sheaths. However, it seemed highly probable that inflammatory conditions with a fair amount of fluid exudate would be very likely to facilitate this passage.

ABSTRACTS

EAR

Present Methods for Testing Auditory Function. MARVIN F. JONES, New York. *Ann. Otol., Rhin. Laryng.*, 1948, lvii, 311.

More reliable methods of diagnosis and of evaluating the auditory function are required. Some of our deductions are made from traditional, but unproven experiments, and the variability of the human element in patient or examiner, or the mechanical element in our instrumentarium may lead to error in diagnosis or inability accurately to compare the results of one observer with another. The physiology of sound reception is based largely upon hypothesis and only to a limited extent on proven demonstrable facts. Helmholtz's theory of tone analysis is at best a hypothesis. The explanation of increase in hearing by bone conduction in tympanic disease is far from clear. Although Bezold's hypothesis is perhaps as satisfactory as any advanced it is not absolutely convincing, and yet we base a diagnosis on it and treat the theory as a fact. The human element ranks high among the potential errors. There is no doubt of a psychological "gain" in many cases. The lethargic, despondent patient will not respond as will the alert hopeful patient. Fatigue too may influence the tests. The audiogram of a tired patient recorded late in the afternoon may well show a much greater apparent heavy loss than a recording made the following morning when rested. The mechanical error in audiometers is another source of discrepancy in results. Audiometers do vary in their accuracy, and there is no way in which the average otologist can tell readily whether his instrument is functioning as it should. Bone conduction readings are too unreliable to make important decisions on their results, nor should important decisions be reached without three air conduction readings, and in addition tuning-fork tests using calibrated forks.

E. J. GILROY GLASS.

Problems of Diagnosis in Obstruction of the Eustachian Tube. FREDERICK T. HILL, Waterville, Maine. *Ann. Otol., Rhin. and Laryng.*, 1948, lvii, 343.

There is an uncommon tendency to think of tubal obstruction as a clinical entity, instead of directing attention to the cause, which may be any condition capable of altering the normal physiological action of the Eustachian tube. In children and even in adults, lymphoid hyperplasia is the commonest cause of tubal obstruction, and should be treated by careful adenoidectomy, followed, if indicated, by irradiation. In the author's limited experience of irradiation alone, the results have not been so good as those from combined operation and subsequently irradiation. Among other causes may be mentioned post-nasal discharge from sinusitis, or the crusting of atrophic rhinitis, dental occlusion, scarring and nasopharyngeal neoplasm. In support of his theory the author quotes four cases, three of nasopharyngeal neoplasm, and a fourth of the combined factor of syphilitic scarring and chronic sinusitis.

E. J. GILROY GLASS.

Nose

Psychogenic Deafness. W. G. HARDY, Baltimore. *Ann. Otol., Rhin. and Laryng.*, 1948, lvii, 65.

The incidence of psychogenic deafness is not known, though reports from Army and Navy aural centres in the United States suggested an incidence of from 10 to 20 per cent., among personnel on active duty who were hospitalized for the treatment of severe hearing disability. How far the military environment contributed to this is difficult to evaluate. The clinician's first concern is with accurate diagnosis. No single factor in the clinical findings is clearly indicative of a psychogenic involvement in hearing disability. There is no typical pattern in this inconsistency. Psychogenic hearing involvement ranges from malingering to hysteria. The psychogenic overlay on organic disease is the most common type of psychogenic involvement. The task of diagnosis is not only to differentiate psychogenic from organic deafness, but also to measure the extent of the psychogenic involvement. Repeated tests are necessary. The key to recovery, once the proportion of organic involvement is known, is the ability of the patient to gain insight into the relations between the casual factors and the symptoms. Under many circumstances this phase of the treatment can often be more readily accomplished by the otologist than by the psychiatrist.

R. SCOTT STEVENSON.

NOSE

A New Method of Treating Angiomatous Growths of the Nose. E. URBANTSCHITSCH. *Monatsschrift für Ohrenheilkunde*, 1948, lxxxii, 425.

The treatment of angiomatous growths in the nose is fraught with much difficulty, as severe haemorrhage is liable to attend any surgical procedure. The author describes his new treatment, which consists in the insertion of magnesium metal needles into the growth. These needles are similar to gramophone needles, furnished with a notch to which anchoring threads may be made fast. Details are given of a case of nasal angioma which caused much trouble from repeated bleeding, eventually necessitating ligation of the external carotid. Treatment with magnesium needles caused the growth to vanish, and enabled the patient to breathe through his nose for the first time in ten years.

H. D. BROWN KELLY.

LARYNX

Streptomycin in tuberculous laryngitis. P. MILOT, Nancy. *Revue de Laryngologie, Otologie, Rhinologie*, 1948, November-December, lxix, 520.

P. Milot publishes his results in treating twenty cases of tuberculous laryngitis with streptomycin. He gives 1,800,000 units of streptomycin in 24 hours, by eight intramuscular injections; at the same time the patient also has 200,000 units by aerosol. If there are any marked reactions (vertigo, cutaneous rashes) the dosage is diminished to 200,000 or 100,000 units each day. About six weeks treatment is necessary to obtain satisfactory results. In ulcerated lesions the results were particularly good, 11 out of 12 healing and one other showing marked improvement; of 15 oedematous lesions 2 healed

Abstracts

and 11 showed marked improvement. In the whole series, only one case was worse. The value of streptomycin was most marked in regard to dysphagia—it disappeared completely and quickly in every case, when present. Vertigo was common, sometimes severe and lasting for several months. Deafness was found in one case only, and that was fleeting, lasting 24 hours. No other case showed even diminution in hearing. The value of this interesting but somewhat enthusiastic report would have been enhanced by controls.

R. SCOTT STEVENSON.

ŒSOPHAGUS

Carcinoma of the Oesophagus. RICHARD H. SWEET, Boston. *J. Amer. med. Ass.*, 1948, cxxxvii, 1213.

Carcinoma of the œsophagus is usually of a squamous cell variety, but the degree of malignancy is of a high order. Dysphagia is usually the first and most reliable symptom. Pain may be present, due to local distension but when it becomes steady within the chest and in the back it usually denotes an inoperable growth. Roentgen ray, when showing the characteristic, irregular filling defect, is a reliable means of diagnosis. Oesophagoscopy and biopsy give positive proof. The failure of Roentgen ray treatment is well known and few patients treated by this means have been made to live much longer than those who were not treated. Surgery offers the only hope and the best prospect of relief in all cases. Transthoracic resection of the growth with a primary intrathoracic œsophagogastric anastomosis is the operation of choice. The operative mortality of 9.5 per cent. (lower end) and 24 per cent. (level of the aortic arch) is by no means prohibitive in consideration of the hopelessness of the disease. Almost 40 per cent. of patients who survive the operation live for three or more years. As a palliative procedure, the operation is the best method of treatment, because even if they do succumb later they can continue to eat in a normal fashion. The article is illustrated and has a bibliography.

ANGUS A. CAMPBELL.

MISCELLANEOUS

Streptomycin. GEOFFREY MARSHALL *et al.*, London. *Brit. med. J.*, 1948, ii, 769.

A committee, of which Dr. Geoffrey Marshall was chairman, have published the short-term results of a Medical Research Council controlled investigation into the effects of streptomycin on 55 patients with one type of pulmonary tuberculosis. Giddiness was noticed by 36 of the 55 patients; absence or reduction of caloric response was not found with the frequency reported in many American investigations. No loss of hearing was reported, except for two cases of high-tone deafness. No clinical "cures" were effected, and only 15 per cent. of the patients were bacteriologically negative (to direct examination and culture) at the end of six months. Toxic effects were common, but in no case did they necessitate cessation of treatment. The patients received 2 grammes of streptomycin intramuscularly daily, in four injections at six-hourly intervals.

R. SCOTT STEVENSON.

Miscellaneous

Cancer Research. R. R. SPENCER, Washington, D.C. *J. Amer. med. Ass.*, 1948, cxxxvii, 1361.

Cancer research has reached the stage in which it can be said: The inciting causes of cancer are multiple and complex. Mammalian cancer cells are derived from normal cells. No sharp line of demarcation can be drawn between the pre-cancerous and the cancerous process. Cancer cells are not supplied with nerves from the host. Cancer cells, like normal cells, cannot be implanted successfully into a foreign species except under highly artificial conditions. A cancer is a group of disorganized cells. A cancer is not a universal cell potentiality, yet in many ways it resembles youthful embryonic tissue.

Little has been learned about the nature of the permanent intracellular change that takes place when normal cells are transformed into cancer cells. Cancer is a process in which certain cells of an organized cell group have become parasitic on and finally fatal to the mother organism—"Autoparasitic". No two cancers seem identical in either causation or behaviour. The cancer problem is basically a problem in growth and a study of growth leads into practically every field of biology. The article has a bibliography.

ANGUS A. CAMPBELL.

Identification of Malignant Tissue. HENRY S. GREENE, New Haven, Connecticut. *J. Amer. med. Ass.*, 1948, cxxxvii, 1364.

Most pathologists identify malignant tissue by morphological appearances alone, but the proof of malignancy lies in its behaviour. Early embryonic tissues frequently resemble cancer, but embryonic tissues undergo differentiation while cancerous tissues do not. Only embryonic tissue and cancer tissue can survive heterologous transfer. If the tissue in question grows in an animal of alien species, it is either embryonic tissue or cancer. The anterior chamber of the eye is used as a transplantation site, and the guinea pig is the animal of choice. The value of the procedure is enhanced from a diagnostic point of view by the increased differentiation in the growing transplant. Completely disorganized tumours often undergo alterations which reveal the organ of origin. Three illustrative case histories are given.

ANGUS A. CAMPBELL.

The Volume of the Bronchial Tree at Various Levels and its Possible Physiological Significance. A. C. HILDING and DAVID HILDING, Duluth, Minn. *Ann. Otol., Rhin. and Laryng.*, 1948, lvii, 324.

There is a small progressive increase in the volume of the tracheo-bronchial tree from the larynx to the bronchi measuring 1.5 mm. in diameter. In this portion of the tree there does not seem to be any very effective air cleansing device except the direct impingement of the air on the mucous blanket lining the tree. From fragmentary data available, there seems to be very considerable expansion in the volume of the tract in tubes less than 1.5 mm. in diameter. Before the cilia cease, the tree has divided into bronchioles which number at least somewhere between 15,000 to 70,000, each of which is lined with ciliated epithelium and a sticky mucous blanket. The composite circumference of these tubes measures many metres. This, "the bronchiolar filter," is an

Abstracts

effective, final device to protect the alveoli from dust and fumes that might gain access to the trachea. One infers that the cilia move off the mucous blanket as is the case elsewhere in the tract. One might also infer that this bronchiolar filter could be even more effective in the matter of dust removal and humidification than the nose, if sufficient secretion is produced. It does not, of course, protect the trachea and the larger bronchi from improperly prepared air.

AUTHORS' SUMMARY.

Novocaine as a Therapeutic Agent in Oto-rhino-laryngology. N. HIBLER.
Monatsschrift für Ohrenheilkunde, 1948, lxxxii, 441.

Injection of the stellate ganglion with 20 c.cm. of 1 per cent. novocaine was found beneficial in the treatment of Ménière's symptom-complex. The treatment was carried out four times in each case with two days between each injection. Seven cases thus treated were relieved of their vertigo and also showed an improvement in hearing. In two instances, hearing actually returned to normal. The treatment of ozaena by infiltration of the stellate ganglion has been recommended by Jannulis and Mandikas. This was carried out in five cases with good result. Details of the infiltration technique are given. Provided care is taken, no untoward after-effects are experienced. The intravenous injection of 1 per cent. novocaine D, without adrenalin, is advised in cases of severe headache due to sinus disease which does not respond to local treatment. Twenty patients thus affected were rendered symptom-free.

H. D. BROWN KELLY.

Neuron Arcs of Clinical Significance in Laryngology. A. C. FURSTENBERG and
ELIZABETH CROSBY, Ann Arbor, Mich. *Ann. Otol., Rhin. and Laryng.*,
1948, lvii, 298.

As the title indicates, an effort has been made to give due consideration to the peripheral and central pathways over which the impulses of respiration are transmitted. Special emphasis is laid on the central tracts in describing certain common respiratory variations. The absence of pathological changes about the brain stem in individuals who had died of meningitis gave rise to doubt that direct stimulation of the vagus nerves and later paralysis of them were responsible for the respective slowing and acceleration of respiration. The inquiry into a more rational explanation for these changes arose particularly from autopsy findings in meningitis secondary to basal accessory sinus disease where the exudate was largely confined to the surfaces of the brain. Laboratory experimentation on monkeys demonstrates well-established areas in the cerebral cortex which when stimulated either slow or accelerate respiration. Autopsy material from patients who died of the type of meningitis above described demonstrated inflammatory involvement of these regions. While the text probes only superficially into the emotional factors responsible for respiratory variations, such as hiccough, sneezing and coughing, it deals specifically with the central nervous apparatus along which emotional impulses are carried. A knowledge of these pathways, and a better understanding of parent-child relationships may widen our knowledge of the psychology of cough and asthma. In discussing the reflex arc of sneezing, an effort is made

Miscellaneous

to offer an explanation on an organic basis for the occasional complaint of nasal obstruction after a submucous resection of the septum in a patient who has wide open nasal cavities. Although the picture is complicated, a disturbance of the pathways of the reflex arc is described which may properly explain this phenomenon.

This initial inquiry into the nervous mechanism of respiration and its common variations leads one to the conviction that much more work needs to be done if we are to achieve a thorough survey of this subject. The one generalization that may be derived from this discussion is that the whole mechanism of respiration is a complicated one governed by a reflex arc and an equally important central nervous system component susceptible to emotional stimulation. In looking for the cause of respiratory changes we must remember not to confine our efforts to an investigation of organs supplied by the peripheral nerves. A knowledge of the central nervous system mechanism and its connections with the peripheral nerve distributions may perhaps help us as laryngologists to think rather than feel our way toward a better understanding of respiratory abnormalities.

AUTHORS' SUMMARY.

OBITUARY

MR. LIONEL COLLEDGE

It is with very great regret that we have to record the death on December 19th, 1948, of Mr. Lionel Colledge at the age of 65. In him we lose one of the leading specialists in diseases of the Throat, Nose and Ear in this country.

The son of Major John Colledge, he was educated at Cheltenham College and Caius College, Cambridge. He completed his medical training at St. George's Hospital qualifying in 1908 and obtaining the M.B., B.Ch. in 1910, and the diploma of F.R.C.S.(England) a year later. He was appointed assistant aural surgeon to St. George's Hospital, and assistant surgeon to the Hospital for Diseases of the Throat, Golden Square, before he reached the age of thirty. His early career was interrupted by the 1914-1918 war in which he served first in command of a casualty clearing station and later as aural surgeon to the First Army. On his return to civil life he devoted himself to the service of his hospitals and began his long association with the Royal Society of Medicine. As honorary secretary, first of the Section of Otology, and then of the Section of Laryngology of that Society he came into close association in the first of these capacities with Sir Charles Ballance, and then in the second with Sir StClair Thomson. With Ballance he carried out the important work in the repair of nerve injury as applied to the larynx and to the face whilst his collaboration with StClair Thomson on cancer of the Larynx brought fame to them both and enabled him to become one of the greatest exponents of the surgery of the throat. The rules of St. George's Hospital, to which he had given long and distinguished service, made it necessary for him to retire from it at the height of his professional ability, but he continued his work at Golden Square and as senior surgeon there took a leading part in the amalgamation of it with the Central London Throat, Nose and Ear Hospital, to form the Royal National Throat, Nose and Ear Hospital with its associated Institute of Laryngology and Otology. His election to the staff of the Prince of Wales General Hospital, Tottenham, and as consultant to the Cancer Hospital gave him further scope for his activities and research and at a later date he became throat surgeon to the Freemasons' Hospital and the West End Hospital for Nervous Diseases.

He became President of both the Sections of the Royal Society of Medicine in turn and continued to represent the Section of Laryngology on the editorial committee of the Society until his death.

He was Semon lecturer in Laryngology at the University of London and Lettsomian Lecturer at the Medical Society of London.

He wrote much in an excellent literary style and his wide knowledge of the literature of his specialty gave the stamp of authority to his articles.

Of the man himself it is difficult to write. His life and interest was almost entirely in his work and he permitted himself few relaxations from it, but he

Obituary

enjoyed travel to foreign capitals and clinics and it was my fortune on many occasions to be his companion on various expeditions either with the visiting association of British Throat and Ear surgeons or alone with him and though it may be said that he was difficult to know, his friendship, once attained, was something to be valued and to be proud of, and the simplicity and directness of his character could not fail to make a most sympathetic appeal. The tragedy of the loss of his only son, killed flying in the R.A.F. in the late war, and his own crippling illness of the last two years adds poignancy to his untimely end.

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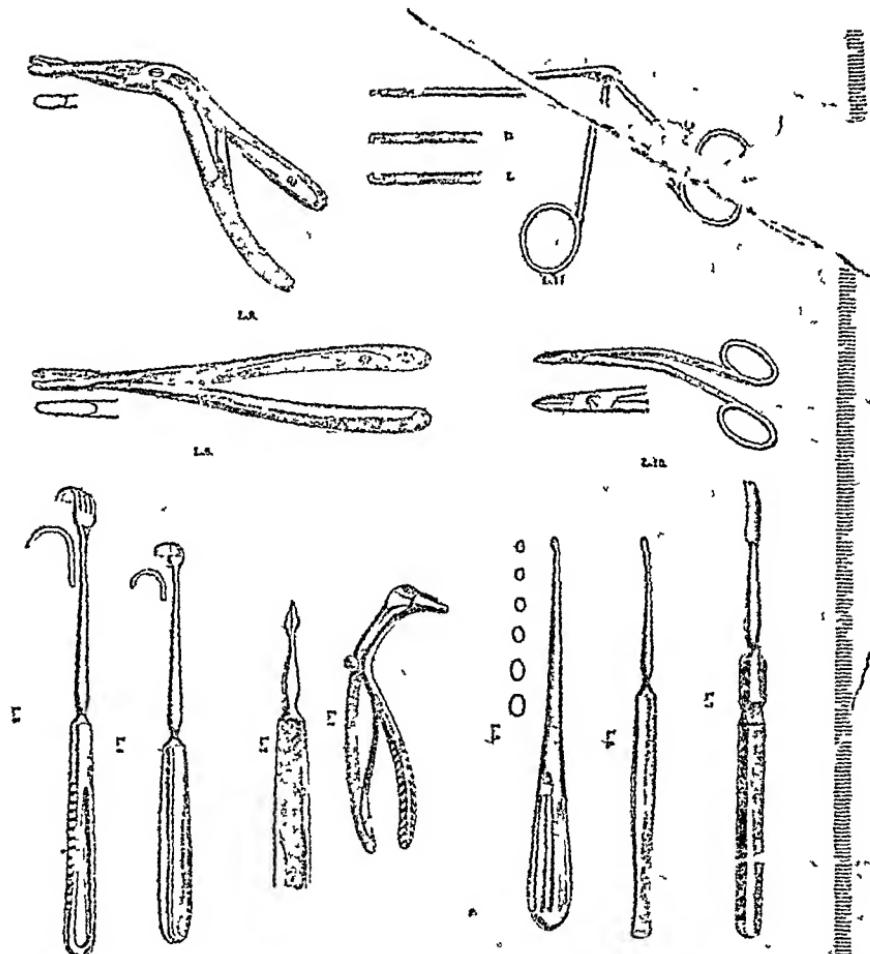
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WITH THE ASSISTANCE OF
G. H. BATEMAN R. G. MACBETH V. E. NEGUS
R. SCOTT STEVENSON J. F. SIMPSON

Contents

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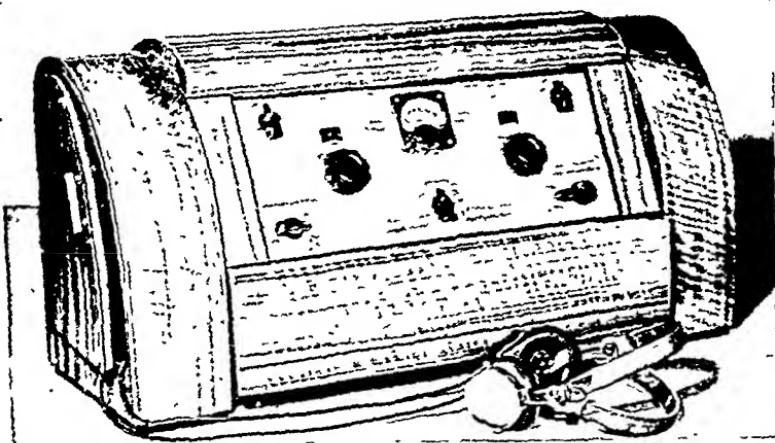
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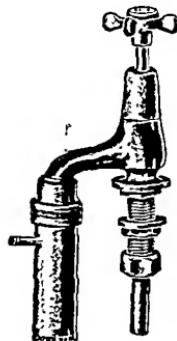
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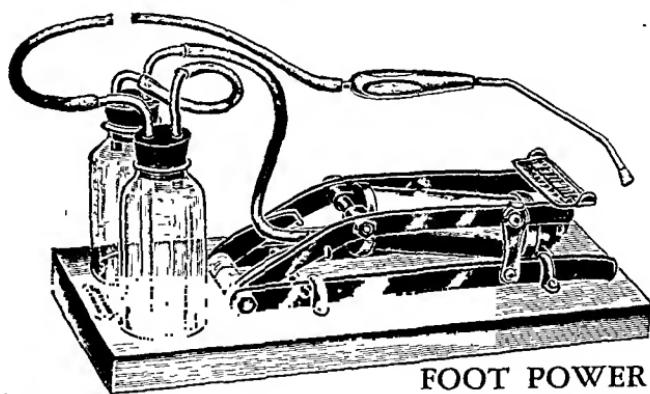
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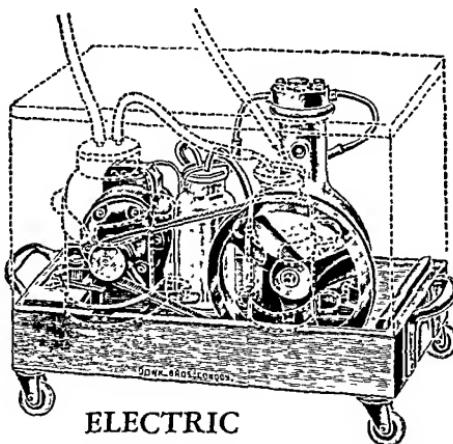
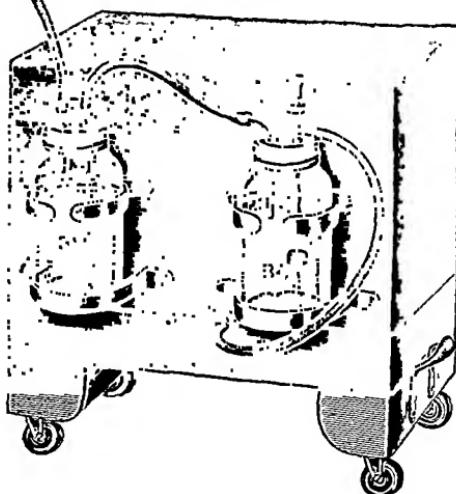


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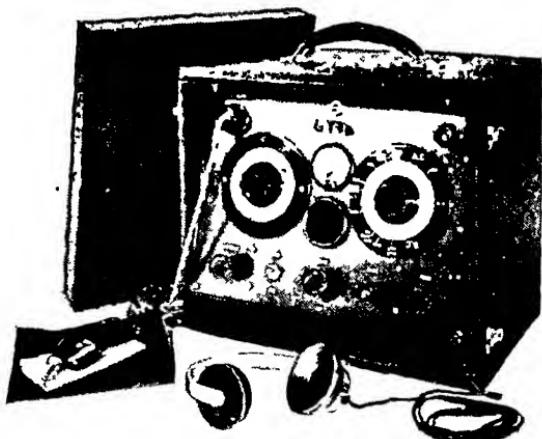
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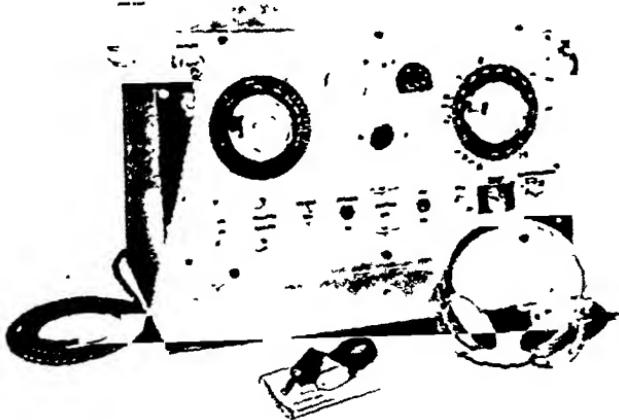
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CONTENTS

RESIDUAL CAPACITY TO HEAR OF PUPILS IN SCHOOLS FOR THE DEAF. A. I. Goodman (Manchester)	551
REMARKS ON A THEORY OF THE EVOLUTION OF THE TETRAPOD MIDDLE EAR. F. R. Parrington (Cambridge)	580
MID-LINE CONGENITAL MALFORMATIONS OF THE NOSE. A. S. Handousa Bey (Cairo, Egypt)	596
PHARYNGO-ŒSOPHAGEAL DIVERTICULUM. S. Horowitz (Glasgow)	600
CLINICAL RECORD—	
Two Cases of Lateral Sinus Thrombosis. E. H. Hadfield and R. T. Hinde (Oxford)	605
CLINICAL NOTE—	
Individual Inserts for Hearing Aids. E. A. Dennison, A. C. Deverell, T. S. Littler and E. Whetnall (London)	610
SOCIETIES' PROCEEDINGS—	
Royal Society of Medicine—Section of Laryngology	614
ABSTRACTS—	
Ear	629
The Relation between Hearing Loss for Specific Frequencies and the Distance at which Speech can be Identified. E. Thayer Curr, Chorda Tympani Nerve Section and Tympanic Plexectomy Samuel Rosen	
Larynx	629
Chondroma and Chondrosarcoma of the Larynx Melvin R Link. Rehabilitation of the Larynx in Cases of Bilateral Abductor Paralysis. De Graaf Woodman	
Œsophagus	630
Œsophageal Varices Charles B Ripstein	
Miscellaneous	631
Vertebrated Magnets for Removal of Foreign Bodies from the Air and Food Passages Chevalier Jackson and Chevalier L Jackson, Tantalum in Rhinoplasty Surgery Samuel L Fox, Mitral Stenosis Associated with Left Recurrent Nerve Paralysis D. F. Lewis and J. W. Scott, Anticoagulant Therapy C. H. Jaquet, Postgraduate Training in Oto-laryngology Francis L Lederer and Joseph G. Schoolman, Functional and Anatomic Relation of Sphenopalatine Ganglion to the Autonomic Nervous System. David Higbee	
GENERAL NOTES	634

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RESIDUAL CAPACITY TO HEAR OF PUPILS IN SCHOOLS FOR THE DEAF

By A. I. GOODMAN (Manchester)

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- (iv) From the result of pure-tone audiometry, all children who might score on the special speech audiometer were tested with that instrument.
- (v) Before any tests were made, the child's teacher was asked to answer the following questions:—
- (a) Do you think the child can understand speech in an m.f. (i.e. ordinary conversational) voice at a distance of 6 feet without lip-reading?
 - (b) Do you think the child can understand speech in an m.f. voice spoken directly into one or the other ear?
 - (c) Has the child any useful hearing for speech?

A. I. Goodman

3. Apparatus Used

(a) *Pure-tone Audiometer*—Western-Electric model No. 6a.

(b) *Speech Audiometer*. This was specially designed and assembled in the Department of Education of the Deaf, Manchester University. It consisted of a gramophone, on which the test records were played, connected *via* an electro-magnetic pickup to an amplifier the output of which could be varied to a known extent by means of a potentiometer. The sound was transmitted *via* the amplifier and potentiometer to a pair of Goodman's No. 181 R headphones, which fitted accurately over the subject's head. The output of the amplifier could be varied in 5 decibel steps from 0 to 120 decibels above normal threshold for the permanent records which were used to obtain the voice threshold, and from 0 to 115 decibels above normal threshold for the soft records which were used for the number tests, these latter records being 5 decibels quieter than the permanent ones.

(c) *The Records*. For obtaining the voice threshold, a record provided by the Post Office Research Station, Dollis Hill, was used. This consisted of a male voice calling out single-syllable words at a constant level with hardly any pause between the words. This was not the same voice as was used in the called number tests.

For the called number tests, recordings of the voices of two males, A.I.G. and H.B.H., were used. These records were made in the Department of Education of the Deaf, Manchester University.

4. Pupils Tested (between June, 1945 and April, 1946)

All children between the ages of 8·0 and 12·11 years at the time of testing in seven schools for the deaf were examined. Three of the schools were residential and four were day schools. The schools were situated in Birmingham, Doncaster, London, Manchester, Preston and Sheffield.

100 of the children tested attended day schools; 243 attended residential schools.

The number of children in each individual age-group is shown in Table I below.

TABLE I.

Age Group	No. of Boys Tested	No. of Girls Tested
8-9 years	38	27
9-10 years	45	31
10-11 years	43	24
11-12 years	37	28
12-13 years	39	31
Total ..	202	141
		343

Capacity to Hear of Pupils in Schools for the Deaf

5. Method of Estimating Percentage Hearing Loss for each Child from Pure-Tone Audiogram

The hearing loss for each child by air conduction was estimated as a percentage, using Sabine-Fowler method (U.S. Council of Physical Therapy, 1942. Tentative standard procedure for evaluating percentage of useful hearing loss in medico-legal cases, *J.A.M.A.*, cxix, 1108).

Many workers have objected to the practice of expressing hearing loss as a percentage, stating that the term percentage hearing loss is meaningless. However, the Sabine-Fowler method meets many of the criticisms of these workers, and when used as a clinical expression of the extent of damage to the hearing, and as a means of classifying the hearing abilities of children in schools for the deaf, the term is valuable.

6. Results

RELIABILITY OF PURE-TONE AUDIOMETER TESTS

(a) *Air-conduction tests.* Repeat tests by air conduction with the same Western-Electric No. 6a audiometer were made on 34 of the children. In addition, 27 of the children had been tested within the previous twelve months by Miss E. Carlill in the clinic.

Fig. 1 shows the variations in hearing loss of the 61 children in the two

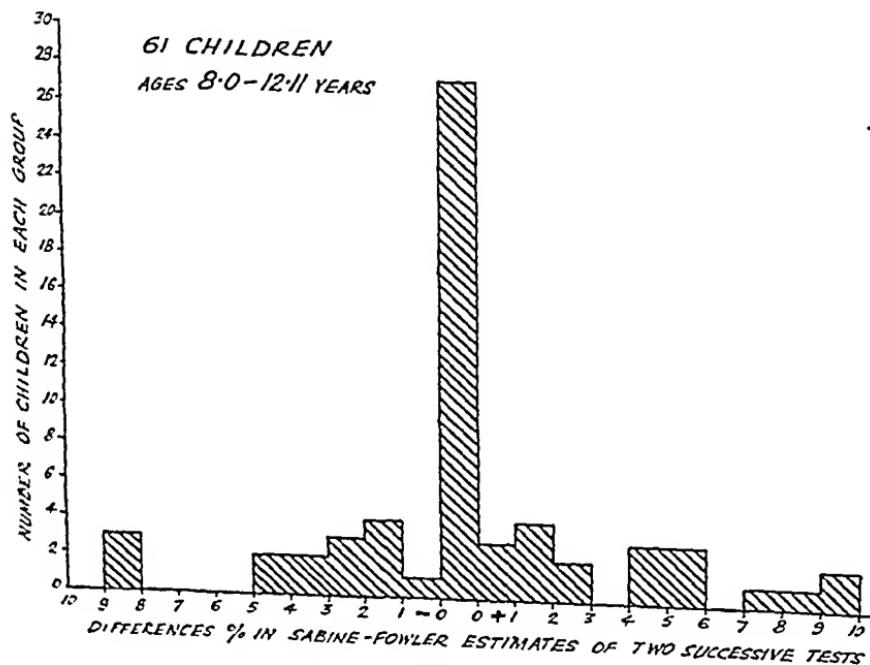


FIG. 1.

Graph showing variations in hearing loss in two different estimations of hearing loss percentage (Sabine-Fowler formula), using Western-Electric 6a audiometer.

A. I. Goodman

different estimations of hearing loss percentage by the Sabine-Fowler method. In compiling this graph all the children who were tested twice have been divided into groups according to the differences in percentage hearing loss between the first and second estimations. Taking the first estimation as a standard, all the children who showed a greater percentage hearing loss, as calculated by the Sabine-Fowler method, in the second estimation have been counted as having a positive difference; those in which the second estimation was less than the first have been counted as having a negative difference. All children showing no difference in percentage hearing loss between the two estimations have been grouped together; those showing differences of 0 to + 0.9 have been grouped together, and so have those with differences of + 1.0 to + 1.9, + 2.0 to + 2.9 and so on. Those showing negative differences have been grouped likewise. From this graph it will be seen that 27 out of the 61 or 44.3 per cent. showed no difference in the Sabine-Fowler percentages in the two tests, 51 out of the 61 or 83.6 per cent. showed differences of less than 5 per cent., while only 2 showed a difference of more than 9 per cent., and none showed a difference of more than 10 per cent.

Figs. 2, 3, 4, 5, and 6 show the variations between the two tests on the individual frequencies tested. As there were 61 children, there were 122 ears re-tested. In compiling these graphs, however, with any particular frequency, those cases have not been included in which no response was

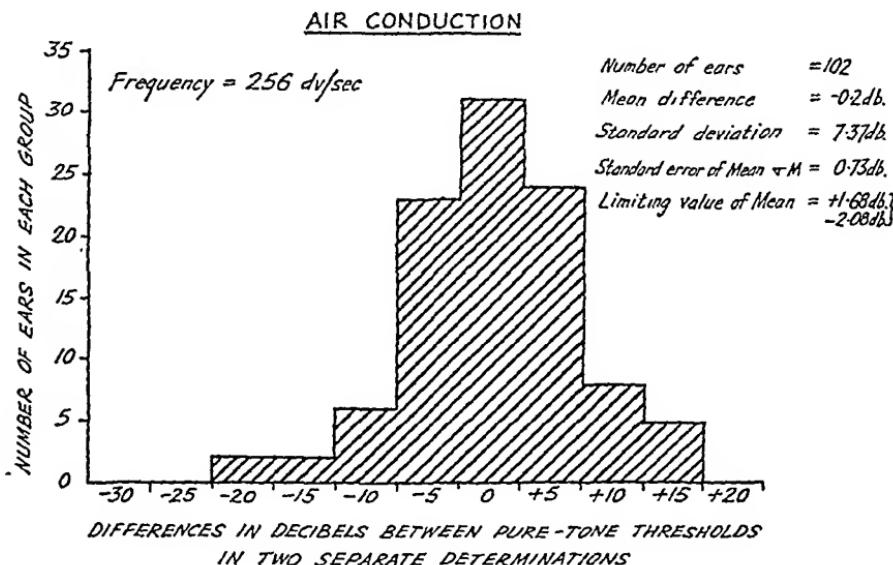


FIG. 2.

Graph showing differences between two separate determinations of the threshold for hearing tested by a Western-Electric No. 6A audiometer at various frequencies in 61 children (ages 8.0 to 12.11 years).

Capacity to Hear of Pupils in Schools for the Deaf

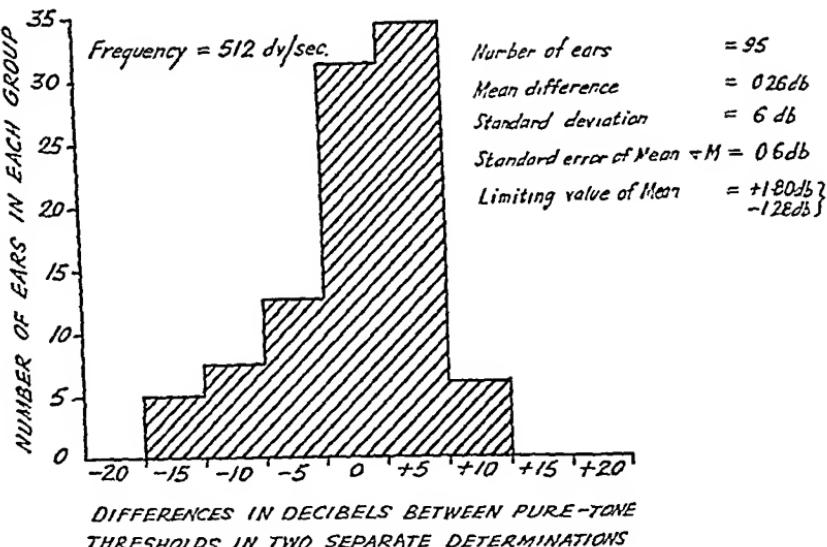


FIG. 3.

Graph showing differences between two separate determinations of the threshold for hearing tested by a Western-Electric No. 6A audiometer at various frequencies in 61 children (ages 8.0 to 12.11 years).

obtained on that frequency on both occasions of testing : to have included them would have been to give a misleading impression of the number of times that there was no difference between the two tests. Each of these graphs has been compiled in a similar manner to Fig. 1, except that now the children are grouped according to the difference in decibels between the first and second determinations of the threshold for hearing on the particular frequency indicated in the graph ; all the children showing

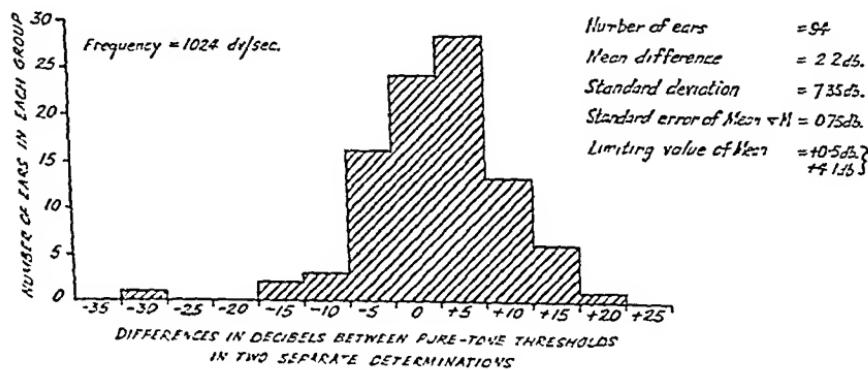


FIG. 4.

Graph showing differences between two separate determinations of the threshold for hearing tested by a Western-Electric No. 64 audiometer at various frequencies in 61 children (ages 8.0 to 12.11 years).

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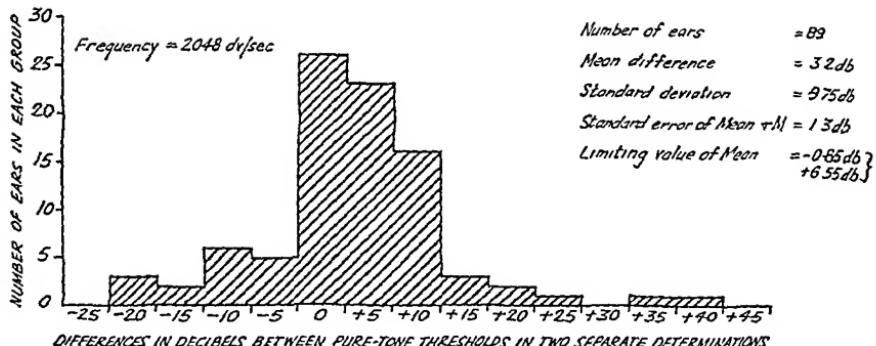


FIG. 5.

Graph showing differences between two separate determinations of the threshold for hearing tested by a Western-Electric No 6A audiometer at various frequencies in 61 children (ages 8.0 to 12.11 years)

the same difference in decibels between the first and second determinations have been grouped together, and the vertical shaded columns indicate the number of children in each group.

Examination of Fig. 2 shows that the number of ears re-tested at 256 dv/sec. was 102. The mean difference was -0.2 decibel, the standard deviation was 7.37 db, and the standard error of the mean was 0.73 db. By means of Fisher's "t" statistic we can obtain a value, 1.88, which is the limiting value of the true mean at the 1 per cent. level of confidence, i.e. we can be practically certain that the true mean does not lie beyond the limits of $-0.2 + 1.88$ and $-0.2 - 1.88$ or $+1.68$ and -2.08 (R. A. Fisher, *Statistical Methods for Research Workers*, Oliver and Boyd).

The readings for the other frequencies, 512, 1024, 2048 and 4096 dv/sec. have been likewise statistically analysed, and the respective values indicated alongside the graphs concerned.

We can state, therefore, that our estimations of hearing loss by air conduction were sufficiently accurate for the purpose of our survey, with a

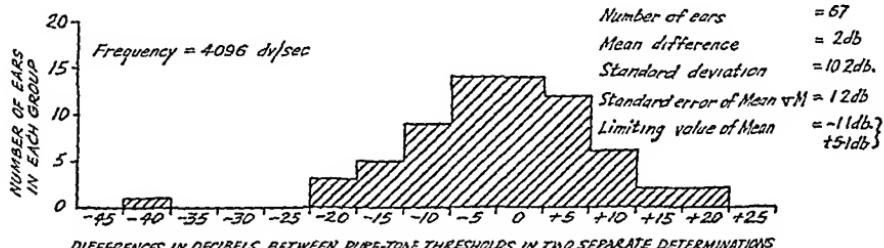


FIG. 6.

Graph showing differences between two separate determinations of the threshold for hearing tested by a Western-Electric No 6A audiometer at various frequencies in 61 children (ages 8.0 to 12.11 years).

Capacity to Hear of Pupils in Schools for the Deaf

BONE CONDUCTION

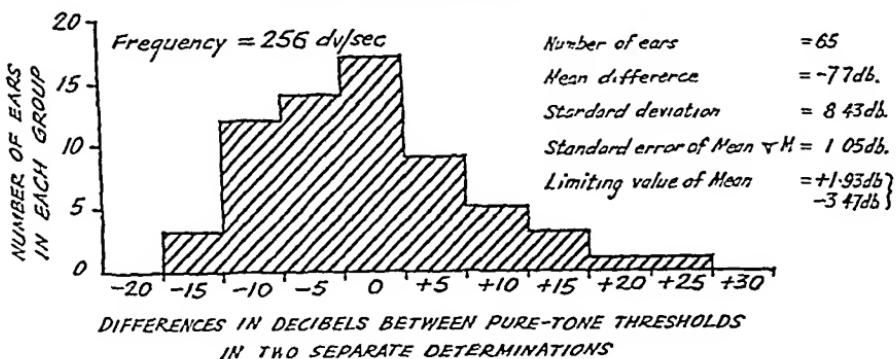


FIG. 7.

Graph showing differences between two separate determinations of the threshold for hearing tested by a Western-Electric No 6A audiometer at various frequencies in 61 children (ages 8.0 to 12.11 years).

standard deviation of 7.37 db. at 256 dv/sec., 9.75 db. at 2048 dv/sec. and 10.2 db. at 4096 dv/sec. The standard deviations at 2048 and 4096 dv/sec. were significantly greater than at the lower frequencies tested.

(b) *Bone-conduction tests.* Repeat tests by bone conduction with the same audiometer, receiver and headband were made in 39 of the children. These children had all given a response to bone conduction at one or more frequencies in one or both cases. Figs. 7, 8, 9, 10 and 11 show the variations between the two tests on the individual frequencies tested.

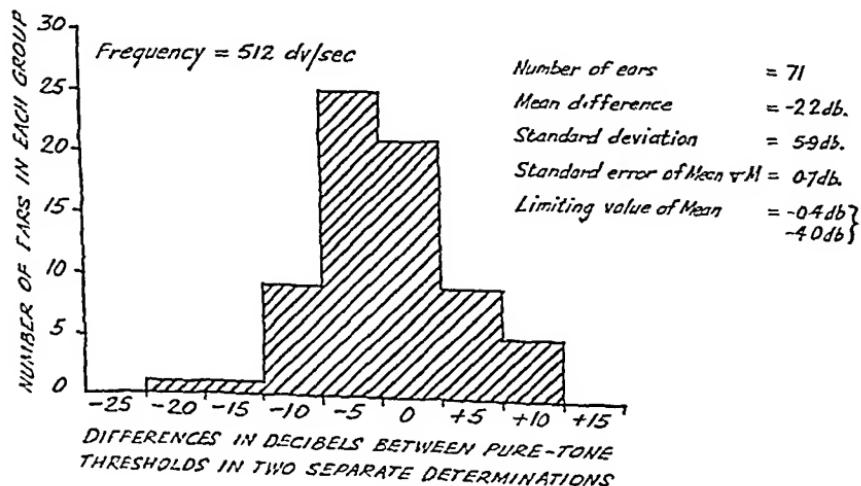


FIG. 8.

Graph showing differences between two separate determinations of the threshold for hearing tested by a Western-Electric No 6A audiometer at various frequencies in 61 children (ages 8.0 to 12.11 years).

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BONE CONDUCTION

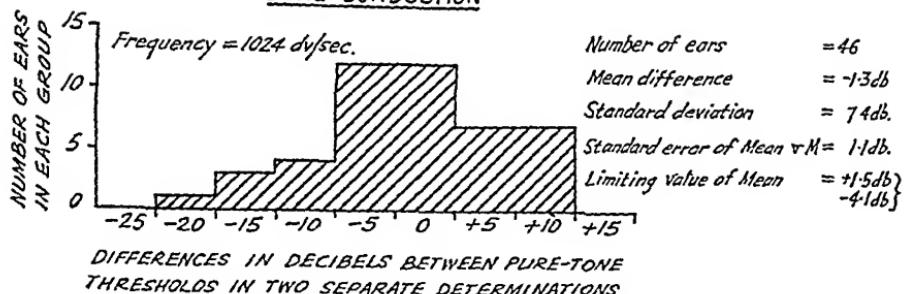


FIG. 9.

Graph showing differences between two separate determinations of the threshold for hearing tested by a Western-Electric No. 6A audiometer at various frequencies in 61 children (ages 8.0 to 12.11 years).

Again, with each frequency those cases have not been included in which no response was obtained in both tests. The graphs have been compiled in a similar manner to Figs. 2 to 6 and the statistical analysis of each graph is similarly given by the side of each figure. From this it will be seen that the reliabilities of the bone conduction estimations are very similar to the reliabilities of the air conduction estimations. However, with bone conduction an error of 6.0 to 8.0 db. is quite serious, because the maximum output of the audiometer is only 45 db. at 256 dv/sec.

RELIABILITY OF SPECIAL SPEECH AUDIOMETER TESTS

Repeat tests with the special speech audiometer were made on 46 children at one residential school for the deaf after an interval of one month. The results of these tests are given below.

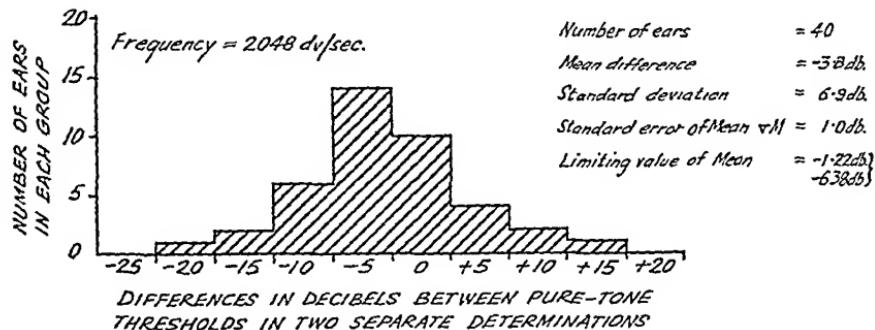


FIG. 10.

Graph showing differences between two separate determinations of the threshold for hearing tested by a Western-Electric No. 6A audiometer at various frequencies in 61 children (ages 8.0 to 12.11 years).

Capacity to Hear of Pupils in Schools for the Deaf

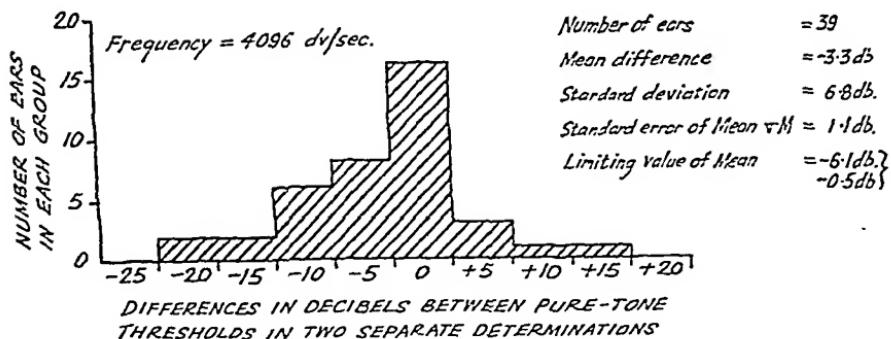


FIG. 11.

Graph showing differences between two separate determinations of the threshold for hearing tested by a Western-Electric No. 6A audiometer at various frequencies in 61 children (ages 8.0 to 12.11 years).

(a) *Reliability of voice threshold determinations.* Fig. 12 shows the differences in the voice threshold between the first and second determinations. As before, the children showing the same decibel differences in voice threshold have been grouped together, and the height of the individual shaded columns indicates the number of children in that group. It will be seen that the voice threshold determinations were remarkably reliable; 23 out of the 46 or 50 per cent. of the children showing no difference between the first and second determinations, and only three showing a difference of 10 db. between the first and second determinations.

(b) *Reliability of called number tests.* For this purpose, 39 out of the 46 children were given one or two repeat tests at the same output of the

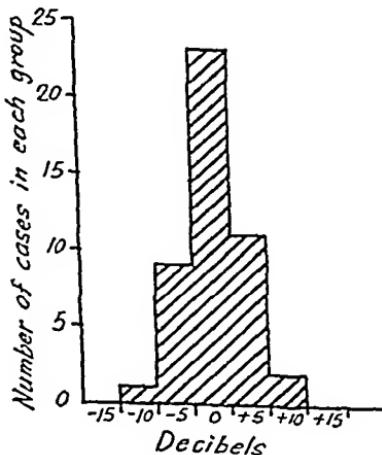


FIG. 12.

Graph showing differences in voice threshold determinations in two separate tests with a special speech audiometer on 46 children (ages 8.0 to 12.11 years).

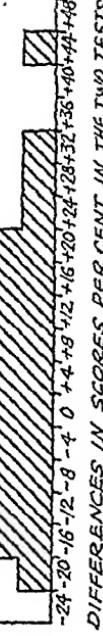
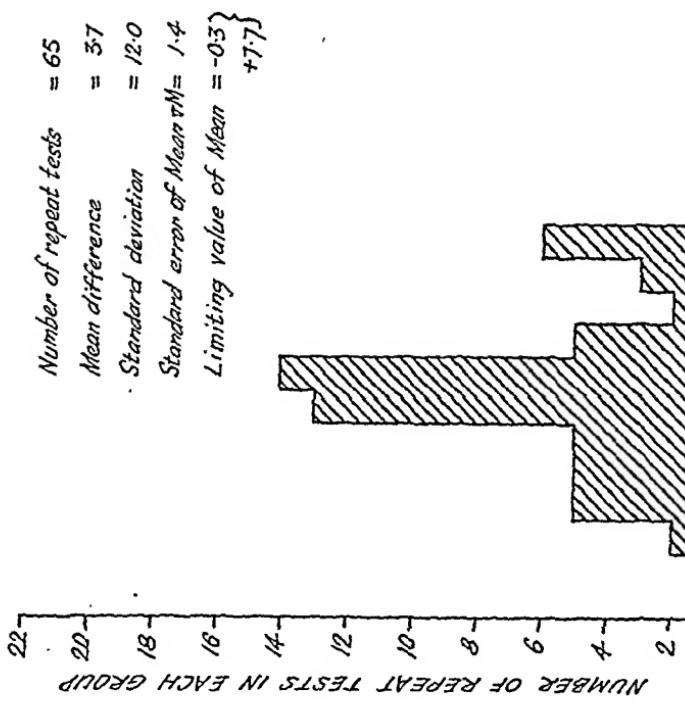
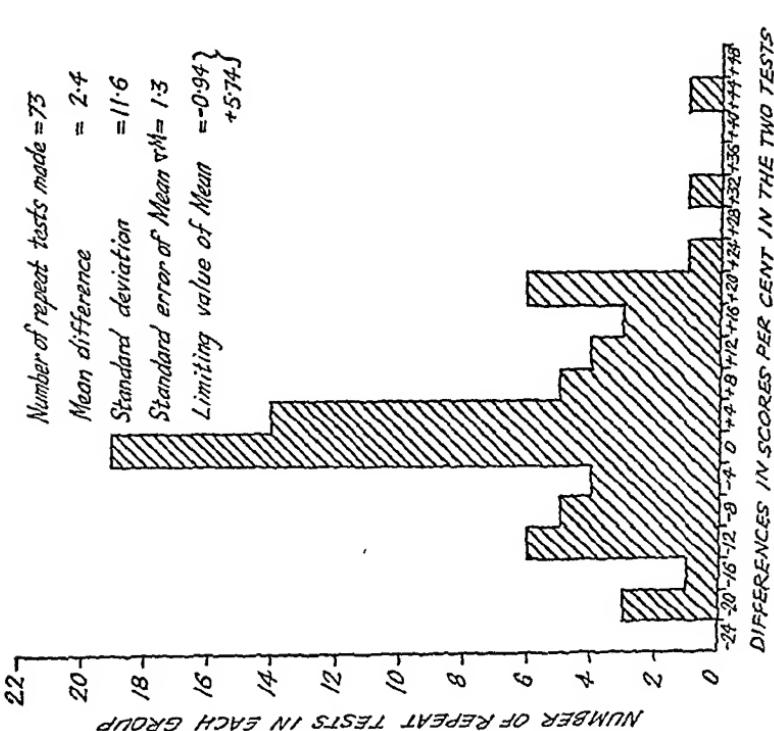


FIG. 13. (a) Reliability of called number tests.

(a) Output of amplifier constant.
 Graph showing differences between percentage scores of children in two separate tests with called number records on special speech audiometer, the output of the audiometer being the same in each of the two tests.

FIG. 13. (b) Graph showing differences between percentage scores of children in two separate tests with called number records on the special speech audiometer, being at the same level above the child's voice threshold constant.



Capacity to Hear of Pupils in Schools for the Deaf

amplifier as the first test, without regard to any difference in the two determinations of the child's voice threshold. The actual record used for the repeat was not always the same as had been used in the first test. The total number of repeat tests made was 73.

A comparison between the scores in the two tests is shown in Fig. 13(a). This graph and the graph shown in Fig. 13(b) have been compiled in a similar manner to Figs. 2 to 12; the height of the vertical shaded columns indicates the number of repeat tests in which the difference from the first test is as shown along the horizontal line.

Another series of repeat tests was made on the same children in which the intensity in decibels in the second test was at the same level above the second determination of the child's voice threshold as the first test was above the first determination of the child's voice threshold. All the 46 children were used for this series and, in all, 65 repeat tests were performed. Again the actual record used for the repeat was not always the same as had been used in the first test. A comparison between the scores in the two tests in this series is shown in Fig. 13(b). Both these graphs (13(a) and 13(b)) have been subjected to a statistical analysis similar to that employed for Figs. 2 to 11, and the respective values are indicated on the corresponding figure.

Comment

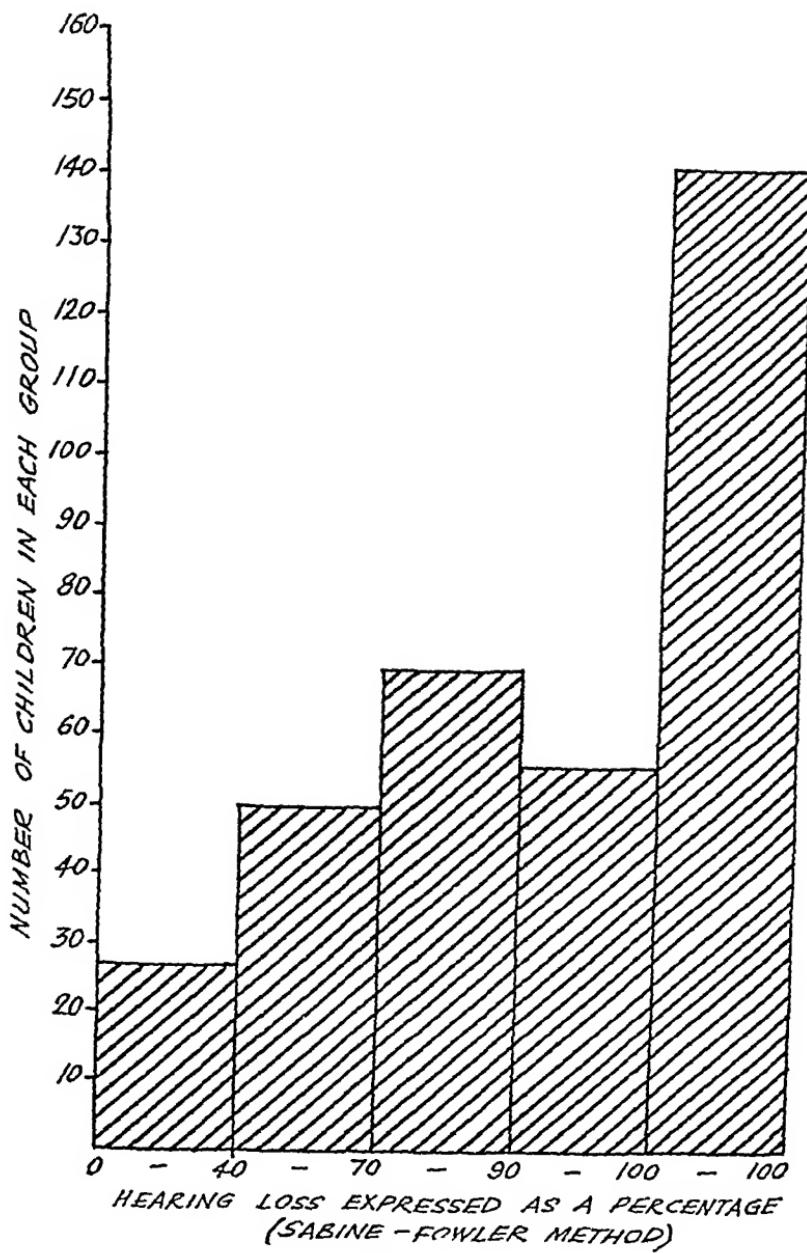
Though the majority of children showed little or no change in hearing between the first and second tests, both with the pure-tone and with the special speech audiometer, a few children did show a considerable difference between the results in the first and second tests. This might be due to the nature of the tests and the apparatus used, but there is also a strong possibility that the cause is that there is an actual variation in hearing in some of these children from day to day.

Results of Pure-Tone Audiometry by Air Conduction

Only twelve of the pupils tested failed to give any response at all on any frequency when tested with the pure-tone audiometer. These twelve cases consisted of two definitely born deaf, two probably born deaf, one deaf from otitis media since eight months of age, six deaf from meningitis (one at five months, one at fourteen months, one at two years, one at $2\frac{1}{2}$ years, one at seven years and one at eight years of age) and one deaf from an unknown cause at an unknown age of onset.

Fig. 14 shows the distribution of hearing loss expressed as a percentage according to the Sabine-Fowler method in all the schools.

Table II shows the distribution of hearing loss in the day schools and residential schools for comparison. The number of children in each group having the same limits of hearing has been expressed as a percentage.



Graph showing distribution of hearing loss as determined by pure-tone audiometry and expressed as a percentage (Sabine-Fowler method) in 343 children in the 7 schools visited (age groups 8.0 to 12.11 years).

Capacity to Hear of Pupils in Schools for the Deaf

TABLE II.

TABLE SHOWING DISTRIBUTION OF HEARING LOSS, EXPRESSED AS A PERCENTAGE (SABINE-FOWLER METHOD) IN DAY AND RESIDENTIAL SCHOOLS FOR COMPARISON

Hearing Loss per cent. (Sabine- Fowler Method)	Percentage of Children in each Group	
	Day Schools	Residential Schools
0-40	10.0	7.0
40-70	18.0	13.6
70-90	24.0	18.9
90-100	16.0	16.5
100	32.0	44.0
Total	100	100

Thus in the day schools 48 per cent. of the children examined, and in the residential schools 60.5 per cent. of the children examined had more than 90 per cent. loss of useful hearing according to the Sabine-Fowler method of calculating percentage loss of useful hearing. Figs. 15 and 16 are

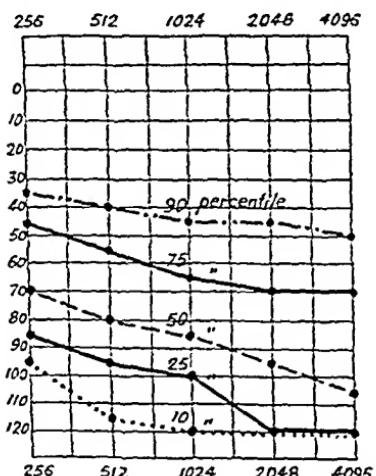


FIG. 15.
Composite audiogram. Four day schools (100 children).

composite audiograms showing the distribution of hearing loss in the day and residential schools separately for comparison. These composite audiograms were obtained by plotting all the audiograms, right and left ears, of all the children tested in the day schools on one chart, and of all the children tested in the residential schools on another chart. A line was then drawn in each figure so that 90 per cent. of readings fell below it, i.e. 90 per cent. of cases have, at each particular frequency tested, hearing losses as great as or greater than is represented by this line. We can call this the "90 percentile line". Other

A. I. Goodman

lines have been drawn in the same way, representing the 75 percentile line, the 50 percentile line, the 25 percentile line and the 10 percentile line.

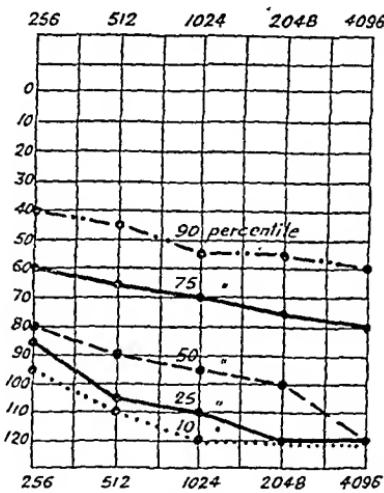


FIG. 16.

Composite audiogram. Three residential schools (243 children).

These composite audiograms also show that the hearing of children tested in the day schools was a little better than the hearing of the children tested in the residential schools.

"High Tone" Deafness

There were nineteen cases in which the loss of hearing of low frequency sounds was moderate or slight, while the loss of hearing of high frequency notes was severe or complete.

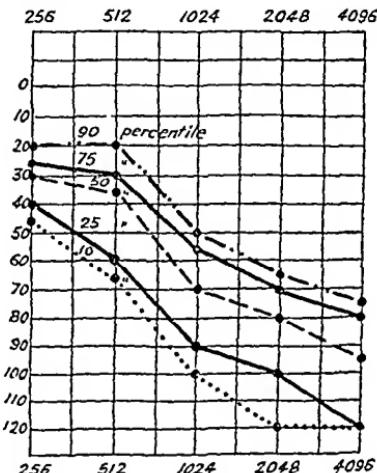


FIG. 17.

Composite audiogram of 19 cases of "high-tone" deafness.

Capacity to Hear of Pupils in Schools for the Deaf

A composite audiogram of these 19 cases is shown in Fig. 17.

The causes of deafness according to the school registers of these nineteen cases were :—

Born Deaf. 11 cases (8 cases admitted by parents to be deaf from birth, 2 cases in which parents said deafness might have been dated from birth, 1 case in which parents said deafness started at 6 years of age).

Meningitis—1 case.

Otitis Media—1 case.

Unknown—6 cases.

All save 2 of these 19 children managed to score 100 per cent. in one of the tests with the special speech audiometer.

Results of Speech Audiometry

(a) *Results of Voice Tests* (m.f. voice of A.I.G. direct listening) (see Table III).

TABLE III.

DISTRIBUTION OF SCORES

	Scoring	100%	90-100%	80-90%	50-80%	30-50%	Below 30%	Cases
At 4 ft.	No. of cases	45	23	7	18	6	245	344
At 2 in.	No. of cases	73	22	16	26	14	193	344

The following table shows a comparison between the results of the voice tests in day schools and residential schools.

TABLE IV.
PERCENTAGE OF CASES

Voice	Scoring	In Day Schools	In Residential Schools
M.F. voice	100%	22.0	9.5
Of A.I.G.	50-100%	18.0	12.4
At 4 ft.	Below 50%	60.0	88.1
M.F. voice	100%	41.0	13.0
Of A.I.G.	50-100%	13.0	21.0
At 2 in. from better ear	Below 50%	46.0	66.0

These results again show that there was a slightly greater proportion of children with useful residual hearing in day schools than in residential schools for the deaf.

(b) *Results of Tests with Special Speech Audiometer* (see Table V)

A. I. Goodman

TABLE V.
DISTRIBUTION OF SCORES

Intensity of Amplifier Output	Scoring	100%	90-100%	80-90%	50-80%	30-50%	Below 30%	Cases
50 db. above normal threshold	No. of cases	8	4	13	7	8	303	343
75 db above normal threshold	do.	56	17	11	19	1	233	337†
" Optimum level " for each pupil*	do.	80	27	12	25	9	190	343

* By " optimum level " is meant that intensity at which the pupil obtained his highest score.

† Six children could not be tested at this level but their results at other levels show that they would have scored.

Table VI shows a comparison between scores with special speech audiometer of children in day and residential schools.

TABLE VI.

Highest Score at any level	Percentage of Cases	
	In Day Schools	In Residential Schools
100%	41.0	16.0
50-100%	15.0	20.2
Below 50%	44.0	63.8

It will be seen that the pupils in the day schools have, on the whole, obtained better scores with the special speech audiometer than the pupils in the residential schools.

Summary of Medical Histories

(a) *Ages at Onset of Deafness.* Table VII shows the ages of the children at the onset of deafness.

Table VIII shows a comparison between the present data and similar data obtained by Dr. Kerridge (Kerridge, Phyllis M. T., 1937, *Hearing and Speech in Deaf Children*, M.R.C. Spec. Rep. Ser. No. 221, London, Fig. 3, p. 11). The number of children on which Dr. Kerridge's percentages are based is not given in her paper. The cases where the date of onset was unknown were not included in her table and for the purpose of comparison they have been omitted here. The correspondence between the two sets of figures is remarkably close.

Capacity to Hear of Pupils in Schools for the Deaf

TABLE VII.
AGES OF CHILDREN AT ONSET OF DEAFNESS

Age at Onset of Deafness	No. of Children	Percent. of all Cases
Under 2 years	213	61.9
At 2 ..	27	7.9
" 3 ..	19	5.5
" 4 ..	10	2.9
" 5 ..	20	5.8
" 6 ..	7	2.0
" 7 ..	5	1.4
" 8 ..	3	0.9
" 9 ..	1	0.3
Unknown	39	11.4
Total	344	100.0

TABLE VIII.
COMPARISON WITH DR. KERRIDGE'S DATA FOR AGES AT ONSET OF DEAFNESS

Age at onset of Deafness	Percentage of all Cases (Goodman)	Percentage of all Cases (Kerridge)
Under 2 years	69.8	64
At 2 ..	8.9	4
" 3 ..	6.2	5
" 4 ..	3.3	6
" 5 ..	6.6	5
" 6 ..	2.3	5
" 7 ..	1.6	3
" 8 ..	1.0	2
" 9 ..	0.3	2
" 10 ..	0	2
" 11 ..	0	1
Over 11 ..	0	0

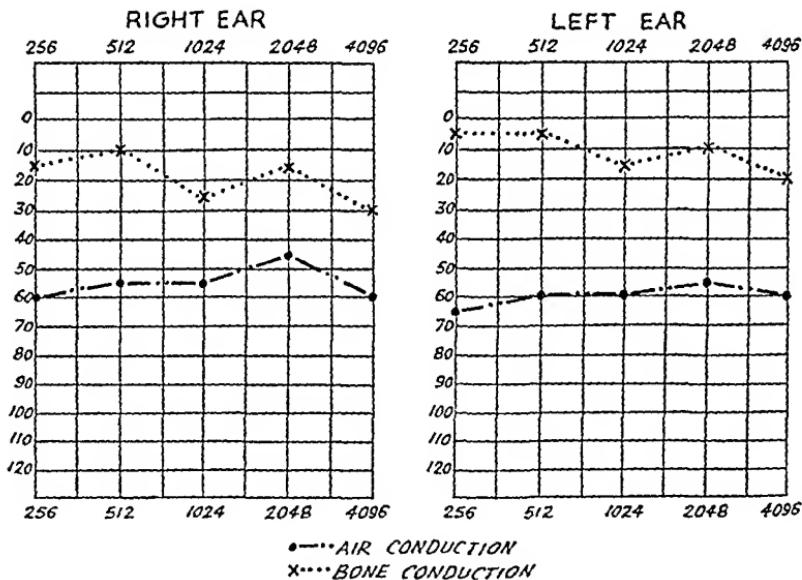
(b) *Causes of Deafness.* Table IX shows the causes of deafness according to the school registers and the number of children deaf from each cause. In several cases the diagnosis of the cause of deafness, based on otological findings and the medical histories, differed from that given in the school registers ; this point will be discussed later.

TABLE IX.

Cause of Deafness (School Register)	No. of Cases	Percentage of all Cases
Born Deaf ..	162	47.2
Otitis Media ..	31	9.3
Meningitis ..	65	18.9
Trauma	2	0.6
Measles	8	2.3
Unknown or miscellaneous	73	21.3
Mumps	2	0.4
	343	100.0

A. I. Goodman

Case A.



Case B.

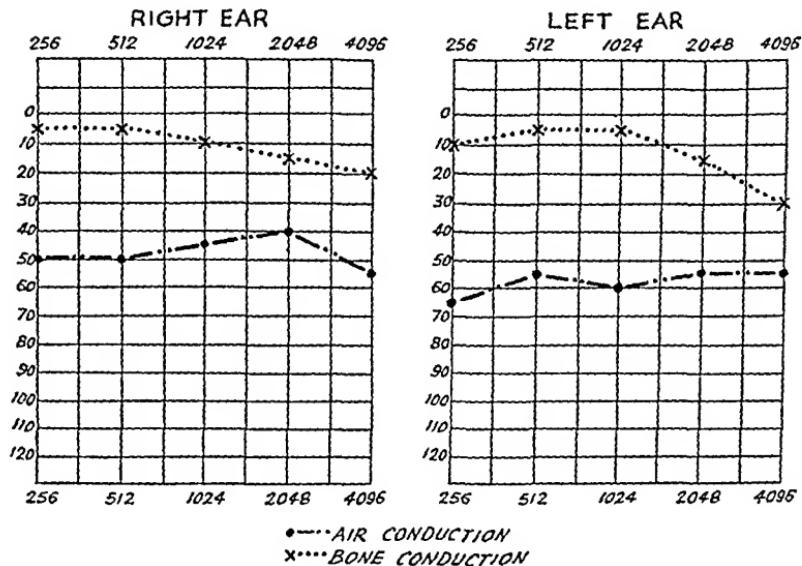


FIG. 18.

Audiograms of two cases with bilateral congenital atresia of external auditory meatus.

Results of Clinical Examinations of Ears, Noses and Throats

- (i) Two children had bilateral congenital atresia of the external auditory meatus with microtia.

Capacity to Hear of Pupils in Schools for the Deaf

One child had unilateral congenital atresia of the meatus and microtia with a normal pinna and tympanic membrane on the other side, yet he was deaf on both sides, though deafener on the atresic side.

One child had a malformed pinna on one side, though both external auditory meatuses and both tympanic membranes were normal.

(2) Thirty-six children had active suppuration in one or both ears.

(3) Forty-one children had definite signs of previous suppuration in one or both ears, e.g. the tympanic membranes on one or both sides showed perforations, scars, etc., though the ears were now dry and free from pus.

(4) Ninety-nine children had dull or retracted ear-drums on one or both sides, though the drums were mobile.

(5) 162 children had normal tympanic membranes on both sides.

(6) One child was absent for the clinical examination.

Audiograms of Three Cases with Congenital Atresia of the External Auditory Meatus

In two of these children the condition was bilateral; in the third case it was present on the right side only.

In the two cases in which the condition was bilateral, the pure-tone audiograms for all four ears were strikingly alike, as shown in Fig. 18. The bone conduction curves in these two cases indicate that the inner ear

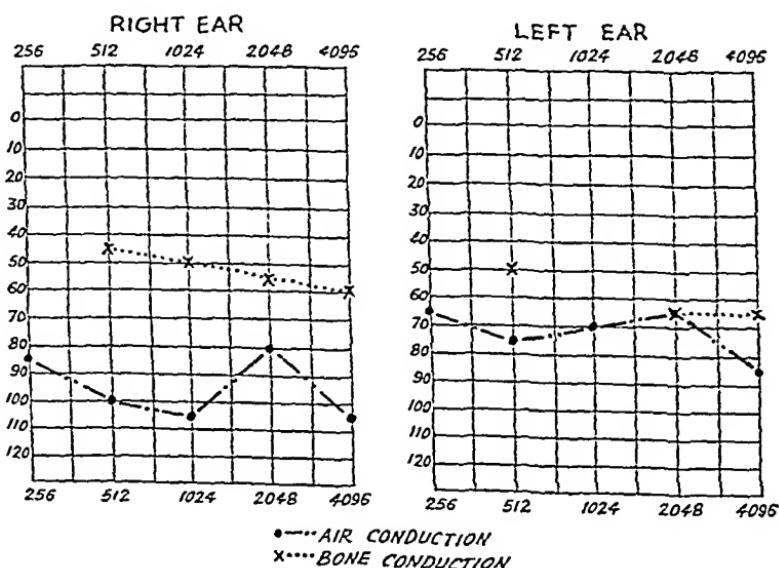


FIG. 19.

Audiogram of case of unilateral congenital atresia of external auditory meatus (right side atretic).

A. I. Goodman

was intact and that the loss in hearing by air conduction was caused entirely by the obstruction of the external auditory meatus.

The pure-tone audiogram of the case with unilateral atresia of the external auditory meatus is shown in Fig. 19. In this child the right ear was atresic; the left pinna was normal, and the tympanic membrane was normal except for a little dullness. However, the audiogram of the left ear shows a severe degree of hearing loss, which must be due to a lesion in the inner ear. The right ear shows an even more severe degree of hearing loss, probably caused by a similar lesion in the inner ear plus the obstruction of the external auditory meatus. The bone conduction curve in the right ear supports this view.

Causes of Deafness

Table IX shows the causes of deafness according to the school register and the number of children deaf from each cause. However, on closer study of the case records, together with the results of otological examination by the author, it was found that of the 65 children in whom meningitis was said to be the cause of deafness, only 42 could be stated to have definitely had meningitis and to have been made deaf by meningitis. Again, the school records indicated 31 children as deaf from otitis media, but our examination proved that 35 children were definitely deaf from this disease. Similarly, of the 162 pupils entered in the school registers as having been born deaf, in only 112 cases did the parents admit that deafness dated from birth, and one of the 112 cases had a history of otorrhœa from three months of age and appeared to the author to be definitely deaf from otitis media.

Thus we arrived at the following figures:—

42 cases definitely deaf from meningitis.

35 cases definitely deaf from otitis media.

111 cases definitely born deaf.

It is interesting to note that no case was met with in the groups tested where deafness was attributed to congenital syphilis.

Aphasia

There were eight cases in which it was said by the school teaching staffs that the child was suspected of being not deaf at all, but suffering from "aphasia". In only one of these cases, however, could the teacher's diagnosis be confirmed on examination. This was a girl of 11 years of age, who was found on pure-tone audiometry to have perfectly normal hearing; she was very intelligent and her written English was very good, but her speech was very poor. She had great difficulty in naming articles, but knew for what purpose they were used when asked to use them. For example, on being shown a fountain-pen and being asked what it was,

Capacity to Hear of Pupils in Schools for the Deaf

she could not reply, but when asked to show how to use it, she promptly unscrewed it and began to write with it. She nodded her head when asked if the article was a pen and could repeat the word "pen", though with difficulty. She responded similarly when asked to name other articles and then to use them.

Of the other seven alleged cases of aphasia, none was actually entered in the school registers as being aphasic, but it was reported by teachers that it was suspected that they were. In none of these cases, however, could this be confirmed on examination. Two were found to be examples of high-tone deafness, four had hearing losses of 54, 62, 65 and 68 per cent. (Sabine-Fowler method) respectively, and one had 100 per cent. hearing loss according to the Sabine-Fowler formula.

Relation between Results of Pure-Tone Audiometry and Cause of Deafness

(a) *According to School Register.* Fig. 20 shows the distribution of hearing loss, expressed as a percentage in the Sabine-Fowler method, according to the different causes of deafness, taken from the school registers. From this it will be seen that otitis media rarely causes severe deafness (above 90 per cent.), most of the cases of deafness from this cause in the schools for the deaf having less than 70 per cent. loss of useful hearing. Most of the cases of meningitis, however, show 100 per cent. loss of useful hearing. The distribution of hearing loss in the meningitis cases is peculiar; 45 have 100 per cent. loss, 15 have 70 to 90 per cent. loss, but only four have 90 to 100 per cent. loss.

(b) *According to Author's Diagnosis of the Causes of Deafness.* It has already been explained how the following figures were obtained for the various causes of deafness, viz., 35 cases in which otitis media was definitely the cause of deafness; 42 cases in which meningitis was definitely the cause of deafness; 111 cases in which the parents admitted deafness dated from birth. The distribution of hearing loss among these three types is shown in the following table (Table X).

The hearing losses are expressed as a percentage (Sabine-Fowler method).

TABLE X.
DISTRIBUTION OF HEARING LOSS ACCORDING TO CAUSE OF DEAFNESS

Per cent. Hearing Loss	Otitis Media	Meningitis	No. of cases Deaf From Birth
0-40%	14	0	2
40-70%	13	1	10
70-90%	5	11	22
90-100%	1	3	21
100%	2	27	56
Totals	35	42	111

A. I. Goodman

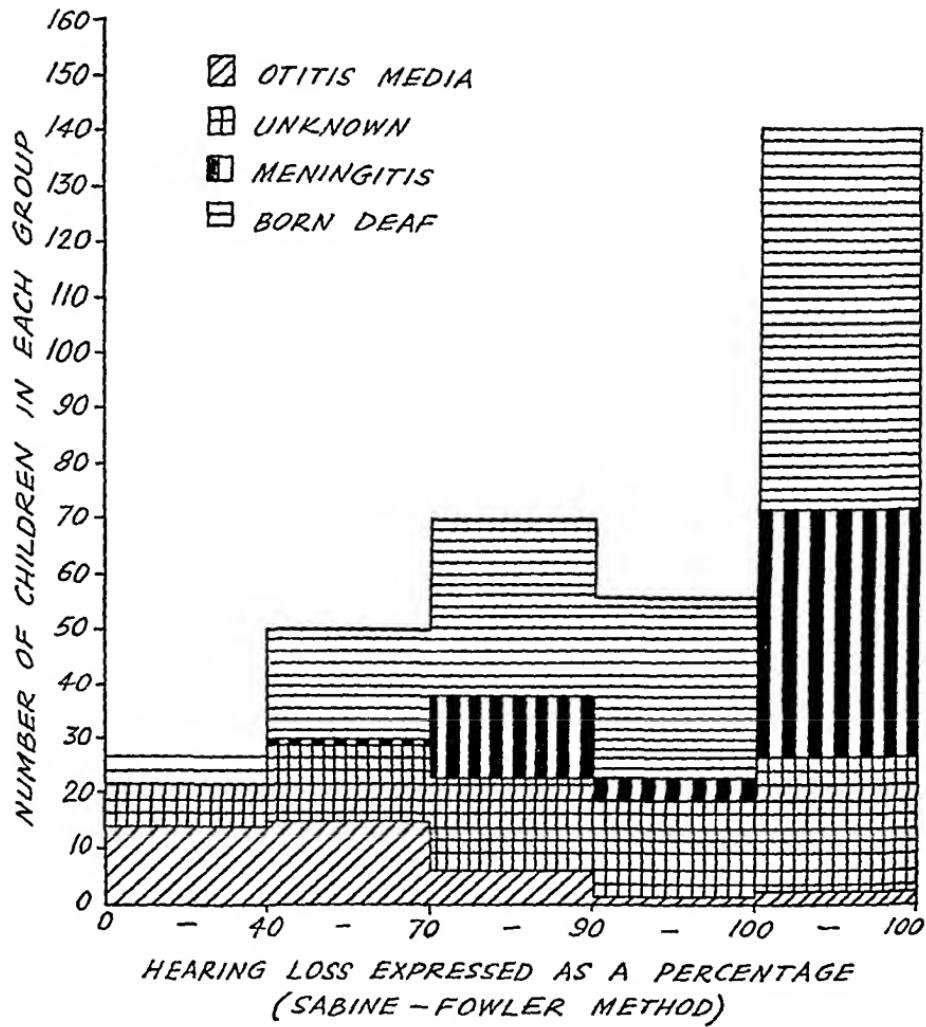


FIG. 20.

Graph showing distribution of hearing loss as determined by pure-tone audiometry and expressed as a percentage (Sabine-Fowler method) according to the cause of deafness in 343 children in 7 schools for deaf. (Age groups: 8.0 to 12.11 years.)

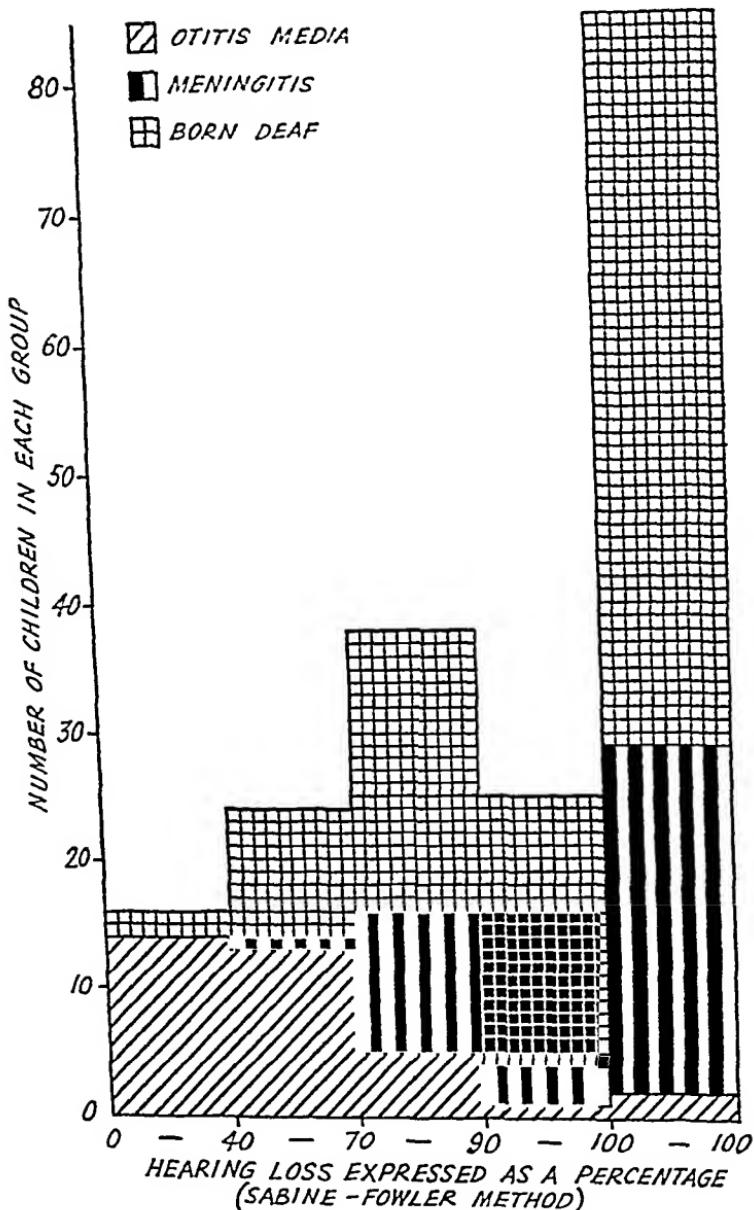
This is shown graphically in Fig. 21.

Again it will be seen that meningitis has caused far more severe deafness among these children than otitis media.

For those to whom the Sabine-Fowler method of expressing percentage hearing loss is not acceptable, these results are represented in a different manner.

Figs. 22, 23 and 24 are composite audiograms showing the distribution of hearing loss in these 35 definite cases of otitis media causing deafness, 42 definite cases of meningitis causing deafness and 111 cases definitely deaf from birth.

Capacity to Hear of Pupils in Schools for the Deaf



A. I. Goodman

in a greater proportion of cases than do children deaf from birth. Children deaf from birth very often have a considerable degree of useful hearing for speech.

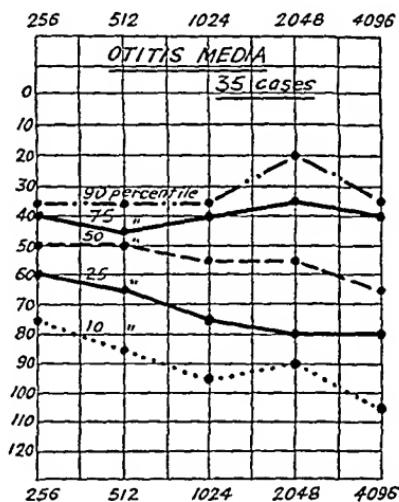


FIG. 22.
Composite audiogram—otitis media, 35 cases.

The 1938 Committee of Inquiry into Problems Relating to Children with Defective Hearing assumed (pp. 6, 7 and 8, *Report of Committee of Inquiry into Problems Relating to Children with Defective Hearing*, H.M. Stationery Office, London, 1938), apparently without any evidence in support of their assumption, that congenital conditions were not an

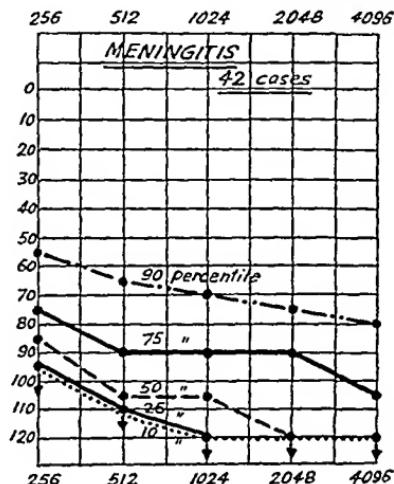


FIG. 23.
Composite audiogram—meningitis, 42 cases.

Capacity to Hear of Pupils in Schools for the Deaf

important factor in the causation of deafness of such a degree that the child still had some useful hearing for speech. On the contrary, the results given here, including only cases definitely known and admitted by the parents to be deaf from birth, show that congenital conditions are the commonest cause of all cases of deafness up to 90 per cent. loss of useful hearing (Sabine-Fowler formula), and about half as common a cause as otitis media of deafness up to 70 per cent. loss of useful hearing (Sabine-Fowler formula). When it is considered, as will be shown later (Table XII) that 64 per cent. of pupils with hearing losses between 50 and 70 per cent. (Sabine-Fowler formula) scored 100 per cent. in at least one of the tests with the special speech audiometer, it becomes apparent that congenital conditions are an important and common cause of deafness of such a degree that a useful amount of hearing for speech is left.

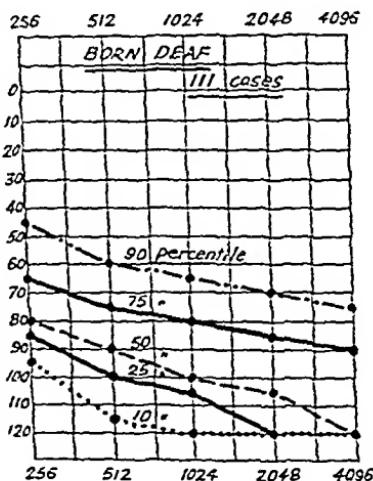


FIG. 24.
Composite audiogram—born deaf, 111 cases.

Relation between Results of Speech Audiometry and Cause of Deafness

For this purpose the 35 cases of otitis media, the 42 cases of meningitis and the 111 congenital cases have been used, in which it was concluded that the diagnosis was definite and correct. The scores with the special speech audiometer of these different cases are shown in the following table. For each case the highest score obtained has been quoted regardless of the intensity level of the audiometer.

These results also show that among the cases of otitis media there is a greater proportion with useful hearing than among the cases deaf from other causes. The number of cases of children deaf from birth who scored 100 per cent. is nearly one-half as great as the number deaf from otitis media, which again helps to show that children with a useful residuum

A. I. Goodman

TABLE XI.

HIGHEST SCORES WITH SPECIAL SPEECH AUDIOMETER OF 35 CASES OF OTITIS MEDIA, 42 CASES OF MENINGITIS AND 111 CONGENITAL CASES OF DEAFNESS

	Otitis Media	Meningitis	Born Deaf
No. of cases scoring 100% ..	25	5	11
No. of cases scoring 50-100% ..	8	7	22
No. of cases scoring below 50% ..	2	30	78
Total No. of cases ..	35	42	111

of hearing for speech include a large proportion of children deaf from birth, despite the statements of the 1938 Committee of Inquiry.

Relation between Results of Pure-Tone Audiometry and Speech Audiometry

No close correlation could be established between the percentage hearing loss and the scores with the special speech audiometer.

This is not to be wondered at, because the Sabine-Fowler formula attempts to give a measure of the practical value to the individual of the residual hearing under the varying conditions met with in life. It is probably not a measure of the individual's ability to understand amplified speech. On the other hand, the method used with the special speech audiometer was not a very searching assessment of each child's ability to hear and understand amplified speech and the scores obtained do not in any way represent a measure of the child's ability to understand speech by means of an amplifier. Thus, we could by no means conclude that every child scoring 100 per cent. in these tests could hear every type of amplified speech 100 per cent. correctly; nor could we assume that all the children scoring 100 per cent. in the tests, even at the same level of intensity, could hear equally well. We certainly would not be justified in assuming that a child scoring 75 per cent. in one of the tests with the special speech audiometer could hear three-quarters as well as one scoring 100 per cent. in the same test at the same level. All we can say with regard to the results obtained with the special speech audiometer is that any child scoring above 50 per cent. could be expected to obtain benefit from the use of an amplifier, and it would be worth while giving such children lessons with amplified speech. It is certainly no detriment to the Sabine-Fowler formula when we find no close correlation between the residual hearing as estimated from this formula and the scores obtained with the special speech audiometer.

However, there is a rough correspondence between the percentage loss of useful hearing as estimated by the Sabine-Fowler method and the results of speech audiometry. In Table XII the children are divided into

Capacity to Hear of Pupils in Schools for the Deaf

groups according to their hearing losses as found by pure-tone audiometry and expressed as a percentage according to the Sabine-Fowler method, and the percentages of children scoring above various levels with the special speech audiometer are indicated. The score taken is the highest score each individual child obtained, regardless of the volume at which the test was made. Such a table might be useful in deciding, in a school where only pure-tone audiometry could be carried out, which children should use an amplifier. The number of cases is too small to make out a separate table for the different causes of deafness.

Comparison of Teacher's Estimate of Pupils' Hearing with Results of Audiometry

In 235 cases the teachers' estimates of the children's hearing abilities agreed more or less with the results of pure-tone and speech audiometry.

TABLE XII.

RELATION BETWEEN RESULTS OF PURE-TONE AUDIOMETRY AND SPEECH AUDIOMETRY IN 343 CHILDREN TESTED. AGE GROUPS 8.0 TO 12.11 YEARS

Hearing Loss Percent. as found by Pure-Tone Audiometry and Estimated by Sabine-Fowler Method	No. of Pupils with hearing loss indicated in col. I	Percent. of pupils scoring 100% with spec. speech audiometer	Percent. of pupils scoring above 90% with spec. speech audiometer	Percent. of pupils scoring above 50% with spec. speech audiometer
0-50	28	89	96	100
50-70	39	64	92	100
70-80	37	51	68	100
80-90	23	13	26	74
90-100	56	5	2	18
100	141	0	0	0

In 85 cases the teachers, for various reasons, gave no estimates of the children's hearing abilities. In 23 cases the teachers' estimates disagreed with the results of pure-tone and speech audiometry. In six of these cases, the teacher over-estimated the children's abilities to understand speech, stating that the children could understand speech in an m.f. voice spoken directly into their ears, whereas none of the six scored above 50 per cent. in the speech audiometry tests. The teachers under-estimated the hearing abilities of the remaining 17 children; each of these 17 children was stated by the teacher to have no useful hearing for speech, yet all 17 scored above 50 per cent. in at least one of the tests with the special speech audiometer, 7 scoring above 90 per cent. and 4 scoring 100 per cent.

These results show that the teachers do have a remarkably accurate knowledge of their pupils' hearing abilities.

A. I. Goodman

Summary of Results

343 pupils between the ages of 8.0 and 12.11 years were tested. 243 of these children were pupils in residential schools and 100 in day schools for the deaf.

Twelve of the pupils tested had no detectable residual hearing.

129 of the pupils tested had some residual hearing, but this, according to Sabine and Fowler, would be of no value to them in the understanding of speech, though the degree of its value varied enormously. 80 children scored 100 per cent. in at least one of the tests with the special speech audiometer and so must have had a considerable degree of useful hearing for speech. There was a greater proportion of children with useful residual hearing for speech in day schools than in residential schools, though the difference was not large.

In the vast majority of cases the deafness dated from before five years of age. Of the known causes of deafness, congenital conditions were the commonest in these children, meningitis was next, and chronic suppurative otitis media next.

Otitis media was surprisingly common in children in whom it was not the primary cause of deafness. Meningitis more commonly caused severe deafness than otitis media; congenital conditions were intermediate between the two. A large proportion of partially deaf children who did have definitely useful residual hearing for speech were deaf from birth.

No close correlation could be found between the percentage loss of useful hearing, as estimated from the pure-tone audiograms by the Sabine-Fowler method, and the scores in the speech audiometer.

The teachers from experience in the classes could estimate extremely well their pupils' ability to hear speech.

Acknowledgments

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REMARKS ON A THEORY OF THE EVOLUTION OF THE TETRAPOD MIDDLE EAR

By F. R. PARRINGTON (Cambridge)

IN a series of recent publications Tumarkin (1948 *a*, *b*, *c*, 1949) has advanced a new theory of the evolution of the tetrapod middle ear based, it is claimed, on considerations of function. The evolution of the middle ear has proved a classic problem in comparative anatomy and a new synthesis of the data will arouse considerable interest, particularly since investigation into the functional possibilities of certain structural conditions is badly needed. But Tumarkin's theory entails the contradiction of data believed by many to be well established, and denies interpretations hitherto considered to be reasonable, and it is important that certain of his statements should not pass unchallenged.

Recent palaeontological investigations have shown that the hyomandibular bone of the early crossopterygian fishes (from which tetrapods are generally believed to have evolved) had five points of attachment and that each of these can be identified with some confidence in the equivalent bone, the stapes, or columella auris, of many tetrapods. These are: two proximal processes abutting against the brain case, the lower becomes the "foot" of the stapes and the upper the dorsal process; an opercular process, for the attachment of the opercular bones protecting the gill chamber, which is believed to form the extra stapes; an attachment to the quadrate which is usually retained; and an attachment to the hyoid in fishes and in at least the young of tetrapods (the hyomandibular or stapes and the hyoid being part of the same (second) gill arch of vertebrates) (Westoll, 1943). The stapes and the region of the middle ear is now reasonably well known in a number of early amphibia and reptiles and in certain instances it is believed that sufficient is known to allow tentative reconstructions to be made and that these reconstructions indicate that a tympanum was probably present. The broad conception, therefore, envisages a well developed and functional middle ear with a tympanum at a very early stage in evolution and, on grounds of economy of hypothesis, it supposes that the simpler structures found in some animals (many of which have often been supposed to be non-functional) result from degeneration.

In contrast to this view Tumarkin supposes that various structural conditions generally believed to be degenerate are all in fact functional

Theory of the Evolution of the Tetrapod Middle Ear

and that they represent stages of evolution prior to the development of a tympanum, a structure which he believes to have been of quite late origin. While many of the views advanced in this theory will no doubt provoke criticism, it is the intention in this account to deal with the conditions of the middle ear of two groups of extinct animals the data concerning which are incorrectly stated by Tumarkin. The condition in these forms is critical to his theory.

The Middle Ear of Early Amphibia

The Labyrinthodontia, which ranged in time through the Carboniferous, Permian and Triassic Periods, form the bulk of the early "stegocephalian" amphibia, and the skull structure is well known in many forms. Posteriorly the skull roofing is cut back on either side to form what is known as the otic notch (Fig. 1). The stapes, which has been

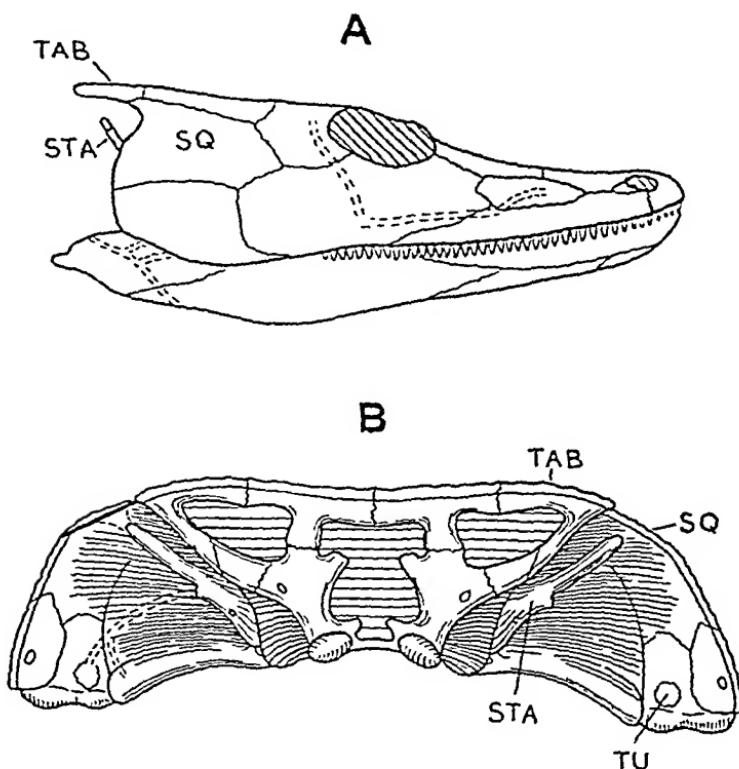


FIG. 1.

Lydekkerina huxleyi (Lydekker), a labyrinthodont amphibian. A. Side view of skull to (TAB) bones. $\times 1$. B. Occiput to show the stapes in position and the tubercle (TU) on the quadrate. On the left side the stapes is restored connected to a tympanum and to the quadrate tubercle and hyoid. $\times 1\frac{1}{2}$.

F. R. Parrington

found in place in many specimens, is a rod of bone which lies between the region of the inner ear and the otic notch and the form of the latter is such that it has long been supposed to have housed a tympanic membrane to which the upper extremity of the stapes would have been attached. Tumarkin categorically denies that in the "early" amphibia the stapes does in fact lie directed to the otic notch and states (1948b, p. 688), without any supporting evidence, that the main connection of the bone was to the quadrate and he asserts that no tympanic membrane could have existed.

The earliest of the known amphibia are the Ichthyostegalians from rocks of either Upper Devonian or lowermost Carboniferous age. Little is yet known about these forms. The Carboniferous labyrinthodonts are the next important occurrence in the time scale, but they are comparatively rare and it is not until the Permian and Trias are reached that amphibian remains are at all abundant. It is convenient to discuss the condition of the ear in these later forms before that of the less well known earlier ones.

The stapes has been found in many Permian and Triassic labyrinthodonts and it has always been recorded as lying between a fenestra ovalis and the otic notch, and has never been found directed to the quadrate. While it would be unreasonable to suppose that all the different workers have been misled by identical post-mortem changes which moved the stapes from its position, the question of its true position is not merely a matter of opinion. In at least seven genera of labyrinthodonts the stapes has been shown to have two proximal processes, or "heads", one fitting into the fenestra ovalis and one being directed anteriorly. These two processes have been compared to the similar "operculum" and "plectrum" of the stapes of modern amphibia (Westoll, 1943). In one labyrinthodont, *Lydekkerina*, the anterior "plectrum" has been shown to rest above a backwardly directed "parafenestral crista" formed by the pterygoid and parasphenoid bones of the skull (Parrington, 1948), while in others, such as *Lyrocephalus* and *Aphaneramma*, the "plectrum" actually fuses with the parafenestral crista (Save Soderbergh, 1936). This fusion places the orientation of the stapes beyond question, since it locks the bone into the skull. Moreover, it locks it into exactly the same position as that which it is described as occupying in the other forms in which it has been recorded. There can be no doubt, therefore, that in typical Permian and Triassic labyrinthodonts the main component of the stapes lay, as it has always been supposed to lie, between the fenestra ovalis and the otic notch. It can be shown, moreover, that a connection was probably maintained with the quadrate but that this connection was formed either by a cartilaginous extension of the stapes or it had been reduced, in the adult, to a ligament. The hyomandibular bone of crossopterygian fishes lay between the neurocranium and the quadrate, and

Theory of the Evolution of the Tetrapod Middle Ear

because the stapes of many reptiles and some modern amphibia maintains the connection to the quadrate, it is believed that it must also have existed in the early amphibia in at least their young stages.

In his Croonian Lecture, Watson (1926) described a pit on the quadrate of the Carboniferous labyrinthodonts which lay directed towards the region of the inner ear and he pointed out that there appeared to be no explanation for this feature except that it housed a cartilaginous extension of the stapes. Subsequently tubercles, which are likely to have been the point of attachment of tendons, have been described on the quadrates of later labyrinthodonts, while more recently a projection has been found on the underside of the stapes of *Lydekkerina* which provides exactly for the upper attachment of the connection (Parrington, 1948). Taken together the foregoing facts strongly support the view that a reduced connection between the stapes and the quadrate remained in the adults of typical labyrinthodonts.

Whether or not a tympanum existed in these forms must remain a matter of opinion, since the chance that such a delicate structure will ever be found preserved is remote. But the supposition that it did exist will be considered reasonable by many on the following grounds. First, as Tumarkin admits, the general arrangement and appearance are in accordance with the view. Secondly, the supposition that a tympanum did not exist forces the conclusion that the stapes was non-functional in spite of the fact that it remained fully developed through a vast period of time and was ideally situated to function. This view is hardly tenable if the functional aspect of the problem is to be given proper consideration as Tumarkin claims it should. Then the condition of the otic notch of such labyrinthodonts as *Tertrema* and *Cyclotosaurus* must be considered. In these forms, quite independently, the otic notch has become enclosed posteriorly by an outward growth of the tabular which reaches the squamosal. This modification provides ideal support for a tympanum but is unintelligible in its absence.

Though brief, the foregoing summary of the most important data will convince most students that the main component of the stapes of the Permian and Triassic labyrinthodonts lay directed into the otic notch, that the connection of the bone to the quadrate was in a reduced condition, and that a tympanum was probably present. There is no doubt about the presence of an open *fenestra ovalis*. This has been demonstrated in *Edops* (Romer and Witter, 1942), a very primitive labyrinthodont from the earliest Permian rocks, and all later forms where the region has been studied. In order that this system should function in terrestrial forms a tympanic cavity must be presumed to have existed. There can be no proof of its existence, though certain modifications of the bones forming the otic notch of some labyrinthodonts have been suggested to be evidence of its presence (Westoll, 1943).

The Carboniferous forerunners of the Permian labyrinthodonts are for the most part less well known, being much more rare, and our knowledge of their ear structures rests almost entirely on the classical work of Watson, who has described the known remains and expounded the biology of the group. Two facts are relevant to this discussion. Watson pointed out that in the only form in which the stapes was preserved it lay directed into the otic notch terminating flush with the surface of the skull (Watson, 1926, p. 206), and he recorded the interesting fact that in *Eogyrinus* and *Palaeogyrinus*, the two forms in which he was able to study the brain case, there was no fenestra ovalis, only a pit, which he called the pseudo-fenestra ovalis, being found. Of the still earlier Ichthyostegalia we know, as yet, very little, only the dermal bones of the skull having been described. Tumarkin's statement that no fenestra ovalis exists in these forms is an assumption based on the conditions found by Watson in the later amphibia from the Carboniferous.

In his discussion of the Carboniferous forms Watson assumed that a tympanum must have been present, the only reasonable conclusion in view of the position of the one recorded stapes, and called attention to the existence of this structure at a time when the fenestra ovalis was not yet perforate. He says, "The fact that a tympanic membrane connected to the otic region by a stapes can be formed before the formation of a fenestra ovalis is an astonishing one, perhaps most readily understood if it originally took place in water, where the amount of energy which can be conveyed by sound waves of reasonable amplitude is greater than in air."

Now Tumarkin (1948a, b, c) asserts that in the absence of a fenestra ovalis a tympanum would be functionless (he likens the condition to cases of classical otosclerosis) and on these grounds he dismisses the possibility of a tympanum not only in the Ichthyostegalia and Carboniferous labyrinthodonts, but also in the later labyrinthodonts. His reasoning would appear to be that since he is convinced that there could have been no tympanum in those early forms which lacked a fenestra ovalis, the presence of an otic notch is no criterion of its presence in later ones. No explanation of the fenestra ovalis is proffered, nor is any real account of the evidence concerning the relations of the stapes. Instead the statement is made that the main connection of the bone was to the quadrate.

In his discussion of the earliest amphibia, Tumarkin states (1948a, p. 879) that a fish hyomandibular could transmit vibrations to the inner ear by four routes, one of which is from the opercular apparatus protecting the gills *via* the opercular process. He says, "Furthermore these animals were not *completely* deaf to sound waves impinging directly on the body surface. A small fraction of the sound striking the gill area would enter and pass *via* the opercular process to the ventral process."

Theory of the Evolution of the Tetrapod Middle Ear

Yet when the only available direct evidence indicates that the hyomandibular bone has been reduced to a rod lying against a pseudo-fenestra ovalis and fitted to a presumed tympanum in place of the gill cover, he denies any possibility of function, and ridicules the assumption of any form of tympanum. No theoretical considerations justify this *volte-face*. It would seem more reasonable to assume, as Watson has done, that a middle ear consisting of a tympanum, stapes and partly formed but imperforate fenestra ovalis would be of functional value in an animal living almost entirely in water. If this system was to function when the animal was on land a tympanic chamber must be assumed. If this is reasonable, then the condition of the middle ear of the later labyrinthodonts becomes intelligible, for it was only necessary to perforate the pseudo-fenestra ovalis for the middle ear to become an efficient transmitter of airborne sound when the labyrinthodonts became largely emancipated from water late in the Carboniferous period. This interpretation is in accordance with the available data and not in contradiction to it.

The Middle Ear of the Theriodontia

The state of organization of the middle ear in the earliest and most primitive reptiles is far from clear (Fig. 2). In some (the Diadectomorpha) there appears to be an "otic notch" formed by the quadrate, and it is known that the stapes was directed towards this region. In others (Captorhinomorpha, Pelycosauria) there is no clearly recognizable otic notch, and it appears that in some of them there may have been no tympanum (Watson, 1948). These early reptiles had primitive limbs and a sprawling gait, and the body rested on the ground except during movement. The stapes retained its connection to the quadrate and in large forms it was very massive. For these reasons it has been supposed that in some instances hearing may have been confined to the transmission of vibrations from the ground *via* the lower jaw and quadrate to the stapes. But very little is yet known of most forms, particularly the smaller ones, and since it is generally believed that the amphibian ancestors of these primitive reptiles had evolved a tympanum, it is usual to suppose that it would have been retained in at least the smaller forms. Watson has shown that among similar reptiles the brain and inner ear bulk proportionately larger in small forms and, consequently, that the stapes becomes disproportionately small in small forms. This is probably a significant factor in the problem (Watson, 1931). Tumarkin believes that there was no tympanum. Moreover, he maintains that there was none in the later "mammal-like" reptiles and that here, too, hearing was confined to the transmission of vibrations *via* the quadrate or the buccal cavity and hyoid. There is now, however, a considerable amount of data concerning the middle ear of the Theriodontia, the order of

"mammal-like" reptiles which most closely approached the mammals in their general structures.

It appears that Tumarkin has two objections to the supposition that a tympanum existed in theriodont reptiles. The first is a belief that the

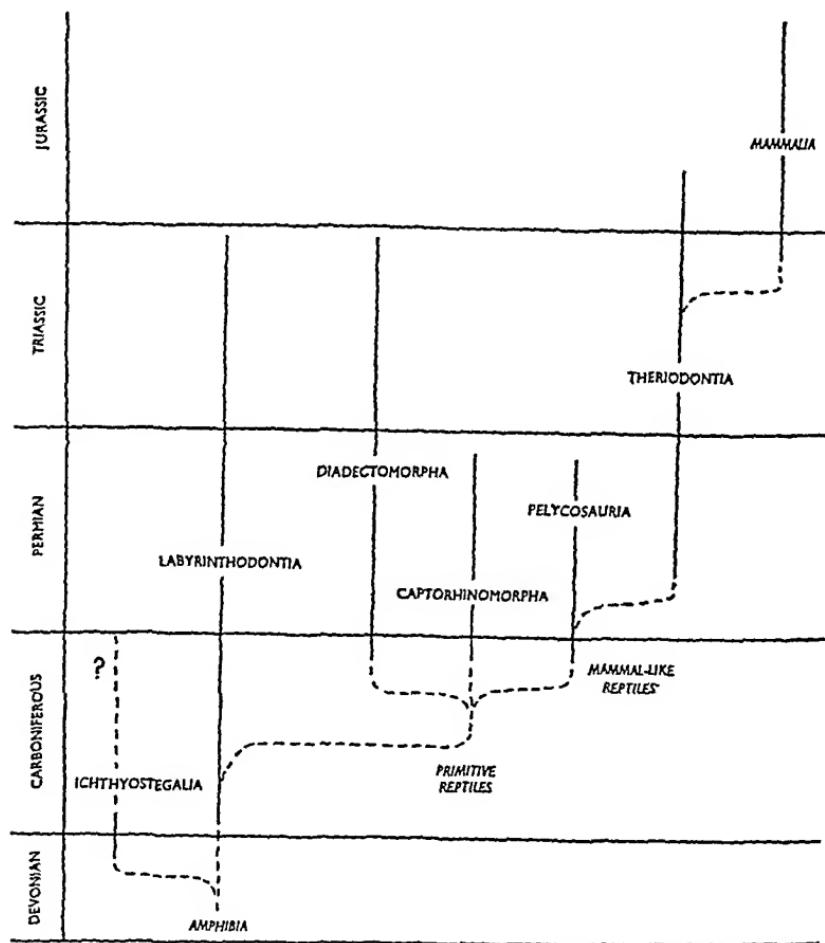


FIG. 2.

Diagram indicating the probable relationships of the various orders of tetrapods mentioned in this discussion. The relationships of the Diadectomorpha are obscure but the Captorhinomorpha, Pelycosauria and Theriodontia represent structural stages in the evolution of mammals.

stapes was so firmly locked to adjacent bones that it could not function. This is entirely contrary to the facts. The second is that the stapes was too massive to function. This statement is not supported by discussion and entirely discounts the small forms where the bone was minute.

Tumarkin's evidence that the stapes was locked firmly in place consists of an illustration of the middle-ear regions of three theriodonts

Theory of the Evolution of the Tetrapod Middle Ear

and one allied reptile which was published by Olson (1944). He says of this, "Note the relatively enormous size of the stapes. In each case the bone is so firmly locked to adjacent bones—especially the quadrate—that a tympanic membrane would have been entirely useless" (Tumarkin, 1948a, Fig. 7). Yet in the first of the four figures the stapes is shown lying free of the quadrate (which, in point of fact, is out of place), and in the fourth figure, that of a cynodont, there is no stapes present—the bone having fallen out of the skull prior to burial. Nor do the other two figures support Tumarkin's assertion. In the second figure the quadrate is out of place, and it is known that the stapes rested in a groove in the quadrate of such animals (Parrington, 1946b), while in the third figure, where the bones are in their right position, there is still no evidence of rigidity and, again, it is known from other evidence that the stapes

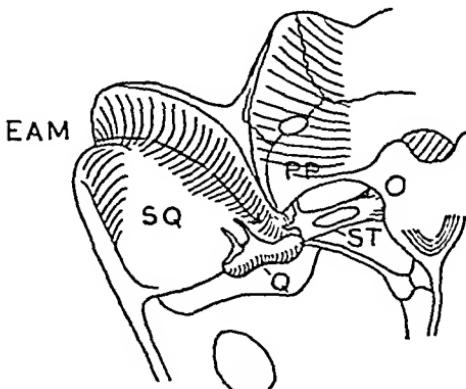


FIG. 3.

Composite restoration of the middle-ear region of a cynodont, seen obliquely from below and the left. The stapes (ST) lies against the fenestra ovalis and makes contact with the quadrate (Q). It is connected to the paroccipital process of the opisthotic (PP) by a dorsal process and has an extra-stapes in the termination of the external auditory meatus (EAM) formed by the squamosal (SQ).

was held loosely in such forms (see e.g. Parrington, 1945). No diagram drawn in two planes can show the full relations of overlapping bones, and Olson made no claim that the stapes was held rigidly.

In point of fact it is well known that in all theriodont reptiles both the stapes and the quadrate were held only loosely in place. The former bone is usually missing, or out of position, while the latter is nearly always lost if the lower jaw is not in place. These very facts have contributed to the difficulty of discovering the full anatomical details of the bones.

The reasons for believing that the theriodont reptiles (and probably other mammal-like reptiles) had a middle ear with a tympanum are as follows.

The most complete details of the middle-ear structures are available in the Cynodontia, a sub-order of the Theriodontia which flourished

during the Trias (Fig. 3). The stapes has been described in a number of genera. Viewed from below the bone is seen to be perforated for the stapedial artery and may appear to be somewhat massive, but when viewed from behind, or extracted from the matrix, it is found to be relatively thin and moderately delicate. While the proximal end lies against the fenestra ovalis the distal end, which in two cases is believed to have been cartilaginous, lies with its anterior part close to the quadrate and almost certainly made contact with that bone. The hindmost part of the distal end of one form, *Thrinaxodon*, is known to have been supported by a slender process which rises to the paroccipital process of the opisthotic (i.e. the posterior bone of the two forming the mammalian periotic). This process can only be compared to the dorsal process in lizards and other reptiles. The stapes of another cynodont, *Trirachodon*, has been shown to have an ossified process extending laterally from the posterior part of its distal end. This can only be compared to the extra-stapes of lizards and other reptiles. If it is permissible to restore a generalized cynodont stapes from these data,* the bone is one with the four processes of a typical lacertid and it is reasonable to suppose that, as in other reptiles, it would have had a connection with the hyoid during development. As in the Green Lizard, all five points of contact of the fish hyomandibular can still be recognized (Parrington, 1946a).

Forty years ago Gregory pointed out that a groove in the back of the squamosal of a cynodont matched a similar hollowing which houses the external auditory meatus in the skulls of mammals, and he suggested that it served the same function in the cynodont (Gregory, 1910). It is now known that this groove occurs in many theriodonts and recently it has been shown that it can terminate in cynodonts in a partly formed tube which turns inwards just beyond the end of the paroccipital process and forms a lip facing the fenestra ovalis (Parrington, 1946a). It is difficult to believe that Gregory's interpretation was incorrect and Tumarkin accepts it, though he does not appear to be aware of the range of forms which possess the feature (Tumarkin, 1948a, p. 882).

Taken together, the foregoing morphological data supply all the skeletal requirements for a middle ear of the reptilian type, but with an external auditory meatus, and the conclusion that a tympanum existed is logical. Its position is clearly indicated by the extra-stapes which reaches towards the termination of the osseous external auditory meatus (Fig. 3).

To-day there is considerable evidence that the middle ear of the earlier (Permian) theriodonts was organized in exactly the same way as

* The dorsal process is extremely delicate and can be expected only when the stapes has not been disturbed in any way. The distal end of the stapes was sometimes cartilaginous (e.g. *Galesaurus*, *Thrinaxodon*) and the extra-stapes would normally be cartilaginous as in many modern forms.

Theory of the Evolution of the Tetrapod Middle Ear

that of the Triassic cynodonts, and the supposition that they, too, had a fully-developed reptilian middle ear is reasonable.*

In place of this interpretation Tumarkin suggests that hearing took place *via* the lower jaw and quadrate in all mammal-like reptiles except those immediately ancestral to mammals, and in these the buccal cavity and hyoid were used. Probably the most outstanding difference between the later mammal-like reptiles and their pelycosaurian ancestors is that while the latter were "belly-crawling" animals, all the later mammal-like reptiles carried their bodies clear of the ground with the limbs posed more like those of mammals, and the lower jaw was in contact with the ground only when the animals were actually resting. The suggestion that airborne sound can be transmitted to the inner ear *via* the walls of the buccal cavity and the hyoid is entirely original and unsupported by evidence.

Tumarkin finds difficulty in believing that the theriodonts had a reptilian middle ear because he is unable to understand how the mammalian middle ear could arise from this condition. He assumes the reptilian and mammalian tympana to be the same. He argues that to achieve the mammalian condition with the stapes, incus (quadrate) and malleus (articular) interpolated between the fenestra and the tympanum (now supported by the tympanic bone—the reptilian angular) it is necessary first for the stapes to lose its contact with the tympanum, then for the quadrate and articular to move into place between the stapes and the tympanum, and then for the stapes to re-establish its contact with the quadrate (now the incus). Such a fundamental reorganization would indeed be "repugnant". The misunderstanding of the orthodox view lies in the conception that the reptilian and mammalian tympana are the same.

Briefly, the view now held is that the reptilian middle ear functioned, perhaps with a chamber extending anteriorly from the tympanic cavity to the space between the angular and its reflected lamina,† until the squamoso-dentary articulation was formed when the tissues held by the angular formed a new tympanum and the articular, quadrate and stapes—still retaining their mutual relations as first established in fishes—were free to form ear ossicles between this new tympanum and the fenestra ovalis. Concurrently the reptilian extra-stapes and tympanum

* Olson (1944) has figured the stapes of a gorgonopsid and a theropcephalian. Data available to the writer indicate that the process identified by Olson as the internal process is in fact the dorsal process.

† It is generally agreed that the angular bone, with its reflected lamina, formed the tympanic bone of mammals. At one time it was believed that the reflected lamina supported the tympanum in theriodonts, but this is not possible and alternative explanations of its function are that it housed the submandibular gland or served for the attachment of an intermandibular muscle. Westoll's suggestion, that it housed an extension of the tympanic chamber, is considered by the writer to be the most probable because it is in accordance with the formation of auditory ossicles from the nearby quadrate and articular.

F. R. Parrington

degenerated and relics of them can be found to-day in Paauw's and Spence's cartilages and Shrapnell's membrane (Westoll, 1943, 1945).

One further point should be made. Tumarkin suggests that there was a stage when the jaw of the mammal ancestor rocked on two hinges. This is improbable and unnecessary. The extremely small Ictidosauria described by Broom (1932) from the uppermost Trias of South Africa are among the most mammal-like of all theriodonts. Here the post-dentary bones of the lower jaw are extremely small and the articular lies close to a part of the dentary which is almost in contact with the squamosal. It is likely that the transitional stage was a hinge formed by both the dentary and the extremely reduced articular in the lower jaw, and the tiny quadrate and a part of the neighbouring region of the squamosal in the skull. Further reduction of the articular and the quadrate would leave the hinge formed only by the dentary and squamosal and the quadrate and articular would be free to become ear ossicles. Such a transition does not require two hinges to function at the same time.

Discussion

The orthodox theory of the evolution of the middle ear is based on three claims. The first is that all the essential structures for its development are present in such widely divergent animals as frogs, lizards, crocodiles and birds. The second is that the palaeontological data are sufficient to show that the same type of middle ear was present in some very early tetrapods. The third is that the simplest explanation is to assume the development of the organ at a very early stage in the evolution of tetrapods and to account for the variations as either degenerations or, in the case of the mammals, a special elaboration.

Tumarkin's theory, in essence, is that every known condition of the middle ear is functional and represents an evolutionary stage towards the fully-developed reptilian type. To support this theory he has found it necessary to deny well established palaeontological data, to accept the suggestion that hearing can be effected through the fore limb and the opercular muscle, and to postulate that airborne sound can be effectively transmitted to the inner ear *via* such dermal bones as the squamosal, and the stapes, in the absence of a tympanic cavity, and also by the walls of the buccal cavity and the hyoid.

The combination of his views leads Tumarkin to conclude that chameleons, which are essentially arboreal lizards and seldom venture on the ground, and which carry the head and body high on slender limbs, hear by means of the lower jaw and quadrate; and that the amphisbaenids, which are highly specialized burrowing lizards and spend their lives underground, listen by opening their mouths.

Tumarkin's assertion that the stapes of the mammal-like reptiles were too large to function with a tympanum raises some very important

Theory of the Evolution of the Tetrapod Middle Ear

points. In fact there is a great range of size of the bone within the group—the very small theriodonts, such as the Scaloposauridae, had stapes smaller than those of some modern reptiles while in the very large gorgonopsia the bone must have been large. As Watson (1931) has shown, the paroccipital process of cynodonts becomes disproportionately longer in the larger forms, and the stapes, if it is to keep the same relations, must increase its length by the same amount. But the following table of measurements of the stapes of three cynodonts shows that the proportions of the bone change as it gets larger. The stapes of the large animal is proportionately more slender and has a proportionately larger stapedial foramen than those of the smaller animals.

MEASUREMENTS (IN MM.) OF STAPES IN CYNODONTS

Cynodont	Length of skull as restored	Length of stapes	Breadth at centre	Breadth at proximal end	Depth at proximal end
<i>Thrinaxodon</i>	..	75.0	6.0*	2.5	3.5
<i>Galesaurus</i>	..	85.0	8.0	3.5	5.0
<i>Trirachodon</i>	..	124.0	15.0	4.5	5.0
Length of stapedial foramen				Breadth of stapedial foramen	
<i>Thrinaxodon</i>	2.75	1.5
<i>Galesaurus</i>	3.0	1.5
<i>Trirachodon</i>	9.0	3.0

* Plus about 1 mm. of cartilage. A smaller cap of cartilage was probably present on the stapes of *Galesaurus*.

Nevertheless, there is a marked increase in the mass of the bone in the largest form and doubtless in other large theriodonts, and the question raised by Tumarkin is important.* It suggests that the size of any skull the design of which requires a lengthy stapes must be limited if efficient hearing is to be carried out.

There are two ways in which the skull of a primitive tetrapod can be modified to prevent the stapes becoming too massive as the skull becomes larger—the fenestra ovalis can be moved laterally or the tympanum can be moved medially. The seymouriamorph amphibia (White, 1939) and, among reptiles, the Diadectidae (Olson, 1947) and the Anomodontia have adopted the former method. In each case the fenestra ovalis has been moved laterally by the formation of a long tube (developed variously from the bones of the otic region) which presumably housed the ductus perilymphaticus, and the stapes has been shortened by a corresponding amount.

* Data concerning the total size of the stapes of various reptiles would become of particular interest if the size of the tympanum necessary to move stapes of various sizes could be worked out.

F. R. Parrington

Consideration of the second method of reducing the length of the stapes, that of moving the tympanum medianly, brings out a number of points of particular interest. In amniotes the stapes remains in contact with, or close to, the quadrate. But changes in skull proportions affect the relative position of the quadrate, and with it the tympanum.

The tympana of frogs, lizards, etc., occupy a superficial position, as did those of the early stegocephalian amphibia, and it seems tolerably certain from the form of the skull that if a tympanum was present in any of the primitive captorhinomorph reptiles, it, too, must have been superficial. Moreover, as is shown by the stapes, its position can only have been approximately behind the quadrate (Parrington, 1946a). With the enlargement of the temporal vacuity in the theriodonts there was an accompanying bending out of the zygomatic arch, the squamosal standing out laterally for some distance almost in line with the occiput. This development, unless it was accompanied by a most marked constriction of the neck immediately behind the skull, would result in a tympanum situated behind the quadrate becoming buried in the soft tissues. The formation of an external auditory meatus would overcome this difficulty. As has already been shown, there is good reason to believe that in cynodonts there was a tympanum posterior to the quadrate and also that there was a bony external auditory meatus formed by the squamosal where it stands out laterally from the occiput.

The stapes and middle-ear region of gorgonopsids, Permian allies of the cynodonts, show almost exactly the same features as the cynodonts (Fig. 4). The stapes is perforated for the stapedial artery and has a dorsal process reaching to the paroccipital process. It rests in a groove in the quadrate and Olson (1942) has shown that in one case at least there is a prolongation of the distal end which can only be compared to the extra-stapes of modern reptiles. When the stapes is placed in position in the groove in the quadrate the extra-stapes reaches approximately to the line of a curve at the back of the dorsal component of the quadrate which is the probable site of the tympanum (Parrington, 1946b). The posterior face of the squamosal is moulded to form a hollow which runs medianly under the upper border and then turns downwards where the squamosal buttresses against the occiput and ends in a distinct lip, not previously described, just above the presumed position of the tympanum (Fig. 4). This hollowing of the squamosal compares closely with the one which, it is generally agreed, housed the external auditory meatus in the Triassic cynodonts.

The theoretical requirement of an external auditory meatus as a consequence of the lateral development of the squamosal was supplied, therefore, in at least some of the quite early theriodonts.

The pelycosaurs, which are structurally intermediate between the primitive captorhinomorph reptiles and the mammal-like theriodontia,

Theory of the Evolution of the Tetrapod Middle Ear

present difficulties. The smaller and more primitive forms are very similar to the captorhinomorphs and, as in these forms, the stapes indicates that if a tympanum was present it must have been situated behind the quadrate. But the larger forms, the best known of which is *Dimetrodon*, have enormous stapes and it has been suggested that such large bones would not have been effective transmitters of sound. Moreover, the absence of any obvious otic notch, the fact that the stapes undoubtedly contacted the quadrate, and the "belly-crawling" posture

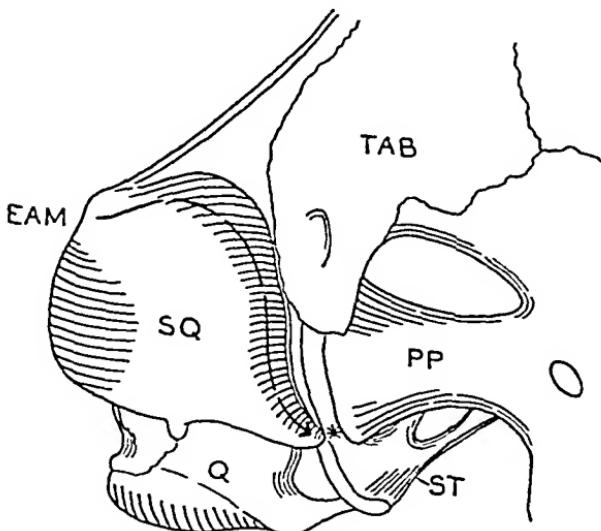


FIG. 4.

Part of the skull of the gorgonopsid theriodont *Ditya* to show the ear region. $\times 1\frac{1}{2}$. The stapes (ST) is somewhat out of place. The head has been moved dorsally out of the fenestra ovalis and the distal end lies behind the groove in the median component of the quadrate (Q) in which it normally lies. The dorsal process (*) is largely obscured by the paroccipital process (PP) in this view. The squamosal (SQ) is moulded in the same region as the hollowing in the cynodont squamosal and presumably housed an external auditory meatus (EAM).

of both captorhinomorphs and pelycosaurs, suggests that hearing may have been confined to transmission of vibrations from the ground *via* the lower jaw and quadrate. But, if there was a tympanum in such groups as the diadectomorphs and the later theriodonts, either it must be supposed that it was retained in the smaller and less specialized Pelycosaurs, or it must have been re-evolved. Romer and Price (1940) have pointed out that a tympanum may well have been present behind the quadrate of *Dimetrodon* though it could not have been superficial. Watson (1948) has investigated the jaw mechanism of this form and also rules out the possibility of a superficial tympanum.

The skull of *Dimetrodon* reaches a length of over 400 mm. and it has undergone certain modifications which are possibly significant. The

quadrate has been carried down until its articular surface is far below the line of the teeth, and there is a comparatively large component of the squamosal on the occiput which grows down and covers most of the quadrate-jugal and part of the quadrate posteriorly.

It would appear, therefore, that if a tympanum was present in such forms it has moved downwards relative to the skull table. In addition the large size of the animal results in the median, exposed component of the quadrate receding a considerable distance—probably over 20 mm.—from the surface. If a tympanum was present in the ancestor of *Dimetrodon* its recession from the surface suggests the need for an external auditory meatus and its downwards movement suggests that the meatus would lie between the curve of the quadrate immediately above the inner of the two condyles and a more lateral and dorsal position. The notch between the squamosal and the tabular and supratemporal bones may have housed the upper part of this meatus where it passed out beneath the upper part of the depressor mandibuli muscle. Such a course would be in accordance with the condition found in theriodonts and, perhaps, other orders of mammal-like reptiles. If evidence of an external auditory meatus can be found in any of the larger pelycosaurs the assumption of a tympanum would be to some extent justified, as would the assumption of a tympanum in their captorhinomorph ancestors. But the need for an examination of the functional possibilities of large stapes still remains.

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Theory of the Evolution of the Tetrapod Middle Ear

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MID-LINE CONGENITAL MALFORMATIONS OF THE NOSE

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MID-LINE congenital malformations of the nose are worthy of record on account of their rarity and of the light they throw on the embryology of the part.

I have met with several cases of median fissure of the tip of the nose, one case of bifid nose, one case of mid-line dermoid cyst, one case of mid-line sinus at the junction of the columella and upper lip, and one case in which a dermoid cyst and two sinuses were present in the middle line over the dorsum of the nose.

The subjects of these congenital malformations were born full term; they had no family history of congenital anomalies or syphilis. The Wassermann reaction was negative.

Mid-Line Fissure of the Tip

The only abnormality in these cases is a shallow fissure in the middle of the tip of the nose—rarely this fissure extends down the columella. The condition is so slight that there is no disfigurement. These cases, if looked for, are much commoner than supposed.

I have had the chance to do submucous resection of the nasal septum in three of these cases, and in all, the septal cartilage was always single and not doubled.

Bifid Nose

In my case, Fig. 1, the frame of the nose is abnormally divided into two halves by a deep, wide cleft that runs through the tip, bridge and columella. The anterior nares and the frontal processes of the maxillae fall wider apart than the normal. The left frontal process of the maxilla is also everted outwards. As a result of these changes the nasal bridge is broadened and made convex at its left outer margin.

The mid-line cleft extends deeply towards the floor of the nose, splitting the septum, which was very broad, into two symmetrical halves. Each half has a septal cartilage lying under the mucosa of the corresponding nasal passage. This was confirmed beyond doubt during the operation for correction of the nasal deformity for which the patient saw me. Each plate of cartilage was attached below to the floor of the nose,

Mid-Line Congenital Malformations of the Nose

the opposite border being bent outwards under the nasal bridge towards the alar cartilages.

The septal cartilages were short of the columella, which was partitioned and made up only of soft tissue.

The upper lip had a complete groove in its under surface. This groove was just visible in the lower part of the red margin of the lip.

The bony alveolus and the mucosa covering it were split in the mid-line; but the mouth was still shut off from that of the nose. Fig. 2 shows radiologically the median split of the premaxilla.

The nasal passages were normal.

Dermoid Cysts and Sinuses

All these were histologically examined and proved to be lined with skin and its appendages and contained sebaceous material "dermoid in nature". Each one had a definite mid-line tract towards the septum, in between the nasal or lateral cartilages, depending on their position.

These cases are demonstrated in Figs. 3, 4 and 5. In the last case the sinus was so minute that it was best demonstrable on radiography after introducing a probe.

Discussion

There are two main points in connection with these malformations that need consideration :

- (1) Their mid-line situation.
- (2) The broadening of the nasal bridge accompanying some of these malformations.

Their *mid-line situation* seems curious and is very difficult to explain on the basis of the present conception of the embryology of the part.

According to this conception the lateral parts of the nasal frame develop round the growing nasal pits of the embryo, while the dorsum, tip, columella and septum nasi develop in the embryonic tissues lying centrally in between these nasal pits.

Authorities give the impression that each of these median elements originates as a single unpaired formation.

E. Barclay-Smith, J. E. Frazer, F. G. Parsons and W. Wright (authors of the *Manual of Anatomy*) state :

"*External Nose* : The dorsum and tip of the nose, and the columella nasi, are developed from the portion of the mesial nasal process which lies between the globular processes." And on the same page they state :

"A cartilaginous nasal capsule is built up round the fossae as they extend up. . . . It presents the cartilage of the septum centrally, formed in the thick mesoderm between the fossae. The vomer develops as a paired ossification in the mesoderm along the lower or free edge of the septal cartilage."

A. S. Handousa Bey

Arey² states : " Paralleling these changes comes a broadening of the head, so that the olfactory pits take a more ventral position and seem to approach the mid-plane. In accomplishing this, the region between is relatively compressed. It becomes the nasal septum."

W. J. Hamilton, J. D. Boyd and H. W. Mossman³ state : " At the same time the nasal pits now called the primitive nasal cavities have become much more extensive ; they remain separated, however, by a deep portion of the fronto-nasal process which becomes progressively thinner to form the primitive nasal septum."

With this conception of the embryology of mid-line structures of the nasal frame, it might be possible to explain the anomaly of bifurcation of the tip of the nose on the basis of " *retarded development* " of the mesodermal elements concerned ; but it would be difficult to explain satisfactorily the presence of a double nasal septum as found in my case of bifid nose or see how dermoid cysts and sinuses lined by skin could be present in the mid-line of the nose.

These malformations point to a bilateral origin for the nose, both sides developing symmetrically to fuse together in the mid-line in early embryonic life.

On this supposition the fissure in cases of bifurcation of the tip of the nose, and the cleft in cases of the bifid nose, mark the line of separation between the two halves of the nose and indicate its bilaterality. The mid-line dermoids and sinuses lined by skin, from the root down to the tip, and farther still down to the root of the columella, mark the line of fusion and are formed from ectodermal inclusions during the process.

Examination of the demonstrative figures given in the textbooks referred to above show that the two nasal pits lie symmetrically separated from each other by the two medial nasal processes which have a central depression in between.

Professor R. Wheeler Haines, Professor of Anatomy, Abbassia Faculty of Medicine, Cairo, who took great interest in these malformations, has directed my attention to demonstrative figures reproduced after G. L. Streeter in *Cunningham's Anatomy*,⁴ which show a mid-line groove in 6 mm. embryos between the olfactory placodes ; this groove seems to get deeper in 12 mm. embryos, but it is absent in 14 mm. embryos.

Thus it appears that the embryonic elements of the nose, both those that give rise to its lateral and median structures (dorsum, tip, columella and septum), have a bilateral origin.

The findings in my case of bifid nose—complete bilaterality of the nasal structures—suggest that each of these median structures starts to develop on either side of the embryonic groove mentioned above as a paired formation, but that soon after their appearance they are moulded into one.



FIG 1

A case of Bifid Nose with double nasal septum, in a girl, 18 years old



FIG 5

X-ray of a congenital Mid-line sinus at root of columella after introducing a probe

Mid-Line Congenital Malformations of the Nose

Persistence of pairing results in the bifid nose malformations. Ectodermal inclusions during moulding or fusion result in the dermoid cysts and sinuses described above.

With this conception of the embryology of the part, all the malformations mentioned above can be easily and satisfactorily explained.

As to the accompanying *broadening of the nasal bridge*, this can be satisfactorily explained on the basis of the present conception of the embryology of the part.

The olfactory placodes, round which the nasal frame develops, lie wide apart, but with the progress of development and the formation of the olfactory pits, the latter tend to come nearer towards the mid-line. Retardation of this process gives rise to broadening of the nasal frame, seen to accompany some of these anomalies.

Summary

Five types of mid-line malformations of the nose are met with and discussed. It is attempted to explain their situation and the broadening of the nasal bridge that accompanies some of them on an embryological basis, but the present conception of the development of the nose seemed unsatisfactory to explain the first point.

It is suggested that the dorsum, tip, columella and septum nasi develop originally as paired formations on either side of the middle line, before they are seen as single structures. This suggestion is based on :

- (1) The presence of a median groove between the olfactory placodes and the developing nasal pits in 4 mm. up to 12 mm. embryos.
- (2) The presence and arrangement of the above-mentioned malformations along the different parts of the middle line of the nose.

I am deeply indebted to Professor R. Wheeler Haines, Professor of Anatomy, Abbassia Faculty of Medicine, Cairo, for the interest he has shown and the guidance he has given me in preparation of this paper. Also, I am most grateful to Professor Y. Aasar, Professor of Anatomy, Farouk I, Faculty of Medicine, Alexandria, Dr. A. Batrawy, Assistant Professor of Anatomy, Kasr-el-Ainy Faculty of Medicine, and Dr. M. Hashem, Assistant Professor of Pathology, for their valuable help.

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PHARYNGO-ŒSOPHAGEAL DIVERTICULUM

By S. HOROWITZ (Glasgow)*

PHARYNGEAL pouch was first observed by Ludlow in 1767. The essential feature of the condition is a herniation of the mucosa of the lower pharynx through the triangle of Zenker, the upper and lower boundaries of which are respectively formed by the oblique fibres of the thyro-pharyngeus and the transverse fibres of the crico-pharyngeus. It is considered by some that this hiatus in the pharyngeal musculature forms an area of potential weakness. The pouch, the wall of which consists of mucosa and of pharyngeal aponeurosis, is situated between pretracheal and prevertebral fasciae. Initially the protrusion takes place in the median plane posteriorly but, because the upper thoracic œsophagus is firmly attached to the vertebral bodies, the pouch must necessarily deviate to one or other side—more frequently the deviation takes place to the left.

The generally accepted theory concerning the aetiology of the condition assumes the presence of inco-ordination of the act of swallowing. The importance of this factor is suggested by the long history of dysphagia in most cases. Normally the transverse fibres of the crico-pharyngeus act as a sphincter at the entrance of the œsophagus—Jackson's œsophageal pinchcock—and should relax during deglutition, when the upper, propulsive, oblique fibres of the thyro-pharyngeus contract. If the transverse fibres fail to relax, there may be great elevation of the intra-pharyngeal pressure. Keith measured the pressure generated in the pharynx on deglutition and found that it rose to a maximum of 45 mm. mercury. Such intermittent pressure, if unduly sustained, would undoubtedly produce strain at the point of obstruction. Repetition of intermittent impulses of high pressure lead to a bulging of mucosa through the thin, unsupported area of the aponeurotic triangle on the posterior wall. The pouch is thus a pulsion or false diverticulum. Once formed, the hernial protrusion tends to increase progressively in the direction of the mediastinum.

Recently some doubt has been cast on the validity of the aforementioned theory. There is full accord as to the place at which the protrusion occurs and the manner in which it develops. The assumption, however, that the triangle of Zenker constitutes a point of weakness is disputed, and it is thought that an acquired defect accounts for the herniation. Supporting this view is the fact that its occurrence in young subjects has

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Pharyngo-Œsophageal Diverticulum

never been reported, apart from cases where there is an organic stenosis of the upper end of the œsophagus. Most examples of pharyngeal diverticula have been found in adults past middle life and the incidence is greater in males than in females (3 : 1). King is of the opinion that the pressure of the lower end of the cricoid cartilage against the spine has a causative relationship to the formation of diverticula. It is only after mature development of the larynx that it is large enough to create sufficient pressure against the cervical vertebrae, and the area at which all diverticula of this type develop is where the lower border of the cricoid cartilage rests against the cervical spine. However, the upper portion of the posterior surface of the cricoid cartilage does not rest against the spine, as does the lower portion, and it is at the inferior border of the cartilage that herniation occurs.

At the site of all intervertebral joints there is a slight ridge, and it was found at operations and at post-mortem dissections that in nearly every case of pharyngo-œsophageal diverticulum the lower border of the cricoid cartilage rested against the ridge of the fifth cervical vertebral joint. It has been assumed, therefore, that the pressure of this ridge against the lower border of the cricoid cartilage results in thinning of the inferior constrictor muscle and the posterior pharyngeal wall at this point of pressure. The relative position of the cricoid cartilage to the vertebrae and their joints depends on the stature of the person, the length of the neck and the degree of curvature of the cervical spine, and it is thought that the last-mentioned factor explains the frequent occurrence of diverticula in the elderly patient. Arthritic changes in the cervical spine very often produce an increased anterior curvature, or it may be the result of a compensatory lordosis in the progressive kyphosis of the thoracic spine of the patient past middle age. If the curvature becomes more pronounced, the cricoid cartilage rests more firmly against the spine.

Another factor in support of this theory is that diverticula occur three times as frequently in men as in women. The male larynx is, on the average, one and a half times the antero-posterior diameter of the female. Men are more muscular and the larynx is consequently held more firmly in contact with the spine.

The firmness and intimacy with which the larynx is held in contact with the spine can be gathered from cases reported in the literature. For example, compression fractures of the fifth cervical vertebra with slight anterior displacement of the body of the vertebra have by pressure caused a bilateral recurrent nerve paralysis. Again, cases are on record where a nasal feeding tube has produced in debilitated patients decubitus ulcers in the œsophagus and hypopharynx on the posterior surface of the cricoid cartilage. Records also relate the production of a uni- or bilateral cord paralysis by a feeding tube. Surgical literature abounds with

reports of such complications, and they confirm the intimate relationship between spine and cricoid cartilage.

Whether this explanation is correct or not, it is impossible to say at the present stage of our knowledge ; but I think it should be taken into consideration, as the assumption of a congenital hiatus is not entirely satisfactory. It certainly fails to explain many facts, e.g. why it never occurs in the child and why it is more common in the male sex. It will require very thorough clinical and post-mortem observation in the future to put the ætiology on a more definite basis.

Case Reports

Mrs. N. W., 72 years of age, was admitted to the wards of the E.N.T. Department on 19.4.49.

History.

The patient had difficulty in swallowing for several years. To begin with the attacks of dysphagia were only of short duration and occurred only at long intervals. As time went on, the attacks of dysphagia became more frequent and troublesome. Four years ago she had to be admitted to the same wards, because her complaint had become very marked. Both a straight X-ray and radiography after an opaque meal revealed no abnormality. The patient was œsophagoscoped and an area of inflammation was seen in the post-cricoid region. Because of its resemblance to a malignant condition, a piece of the tissue was removed for biopsy. The Pathologist's report read as follows : "There is some hyperplasia of the squamous epithelium of the œsophagus, but no evidence of malignancy."

During the period that followed her discharge from the Infirmary until her readmission on the above date, she continued to have periods of dysphagia. About a fortnight prior to her admission, she felt that "something got stuck in her throat" while eating a meat dish, and complained of a sudden sensation of pain in the region of her suprasternal notch. As the discomfort did not show any signs of improvement in the following two weeks, she came to the Infirmary.

Examination.

The general condition of the patient was poor, she appeared toxic, her tongue was dry and furred. No abnormality was found on examination of her neck. Her breathing was slightly laboured. T. 98.6°, P. 110, R. 24. The blood examination showed a mild secondary anaemia and a leucocyte count of 12,500 per c.mm.

Respiratory System.

The percussion note was impaired over the bases of both lungs and the respiratory movements were somewhat diminished. The breath sounds were distant and weak and the conduction of the spoken voice was diminished. It was thought that the condition was one of bilateral pleural effusion.



FIG. 1.

Pharyngo-oesophageal Diverticulum in antero-posterior view.



FIG 2
Pharyngo-oesophageal Diverticulum in lateral view.



FIG 3
Enlargement of Diverticulum



FIG. 4.
Enlargement of Diverticulum.

Pharyngo-Œsophageal Diverticulum

The other systems showed no gross abnormality. Indirect laryngoscopy showed nothing abnormal. Radiological examination was carried out. The films showed a roundish opacity, within which were translucencies and which was situated just to the right of the fifth and sixth cervical vertebrae (Figs. 1 and 2). The presence of an opaque foreign body was excluded and, considering her previous history, the diagnosis of pharyngo-œsophageal diverticulum was made (Figs. 3 and 4). A barium swallow was not carried out, because the patient was not considered fit to be taken to the X-ray Department, which is a considerable distance away from the E.N.T. wards.

Although the patient's poor general condition was fully appreciated, it was decided that a laryngoscopy was advisable because of the patient's continuous complaint of pain in her neck and the possibility of the presence of a foreign body, not opaque to X-ray. This was carried out with a minimal amount of disturbance to the patient.

There was no foreign body at the pharyngo-œsophageal junction. In the post-cricoid region there was a raised, red, œdematosus area, which bled easily on touch and which showed in its centre what appeared to be a shallow, oval ulcer, and which was considered to be the opening into the diverticulum. However, the possibility of an ulcerating malignant neoplasm of the post-cricoid region was considered and great care was taken in removing a piece of the tissue for biopsy. Histological examination, however, showed only inflammatory changes and no evidence of malignancy. The patient's condition deteriorated and she died two days later.

A post-mortem examination was performed and the relevant points were as follows :

On the right lateral wall of the œsophagus at the level of the lower border of the cricoid cartilage, there was a shallow, oval ulcer measuring about $\frac{1}{2}$ cm. in its longer diameter. This ulcer had an opening into a diverticulum, which was lying parallel to the œsophagus and extended on its right side downwards for about 5 cm. and upwards for about 2 cm. This diverticulum was lined with epithelium and was of the "pulsion" type. It contained pus, and fibrinous exudate was adherent to its wall. Near its lower end it had a small perforation and the thick pus had tracked downwards parallel to the œsophagus and on its side to the hilum of the right lung, where infection of both pleural cavities had occurred. There was a mediastinitis surrounding this abscess track. A second abscess was present in the muscles of the neck anterior and lateral to the right lobe of the thyroid gland and was well encapsulated. The pus was thick and of greenish colour. The œsophagus distal to the orifice of the diverticulum was of normal structure.

There was a bilateral empyema of the pleura covering the basal lobes of both lungs. There was no pneumonia in the basal lobes and the empyema was clearly related to the mediastinal infection.

Comment

The diagnosis of pharyngo-œsophageal diverticulum was made, but was not confirmed by demonstration of the pouch after an opaque meal. As it turned out, it was fortunate that the barium meal could not be given,

because the contrast fluid would have found its way into the mediastinum. Without this essential examination other conditions, such as calcified aberrant thyroid adenoma and a calcified lymph gland, had to be taken into consideration. For practical purposes, however, the last-named conditions could be excluded, as her previous history pointed to the diagnosis of diverticulum.

The diverticulum had probably perforated at the time when she thought that something had become impacted in her oesophagus and felt the severe pain in the region of the supra-sternal notch. It was more in the nature of a slight leak. The possibility that a bone may have produced the perforation was considered, but no foreign body was found at the autopsy. Her general condition, although very poor, did not lead one to suspect the gravity of her complications, both intrathoracically and in the neck, which must have existed for some time, as could be concluded from the quality of the pus and the encapsulation of the abscess. The pain she complained of in the neck was to a great extent due to this abscess.

As in most cases, the symptoms only became obvious at an advanced age. As mentioned before, the condition occurs more frequently in the male sex and is situated more commonly to the left of the vertebral column. In these respects our patient shows a digression from the typical textbook case. It is a point of interest that four years ago, and at her recent examination, the tissue changes in the post-cricoid region so closely simulated malignancy on direct examination that both times biopsy specimens were taken for histological examination. It is a well-known fact, of course, that the mucous membrane of diverticula in this region suffers from a chronic inflammatory change, which must be regarded as precancerous, for malignant disease, extremely rare in the male hypopharynx, is not uncommon in pouches of long duration. The death of the patient was the result of toxæmia, which led eventually to cardiac failure.

Summary

The pathology and pathogenesis of pharyngo-oesophageal diverticulum are discussed. An acquired mechanism in its production is suggested, in contradistinction to the present-day theory of a congenital weakness of the posterior pharyngeal wall.

A fatal case of a perforated diverticulum is described and the relevant post-mortem findings mentioned.

I am indebted to Mr. Stephen Young, Senior Surgeon of the Department, for his helpful criticism.

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CLINICAL RECORD

TWO CASES OF LATERAL SINUS THROMBOSIS

By E. H. HADFIELD and R. T. HINDE (Oxford)*

CASE I. Records No. 16452. Admitted 29.10.47.

History.

The patient was a previously healthy man of 42. He had noticed a right aural discharge and deafness for six months, but had not sought treatment for this. Four days before admission he developed right earache and this became more severe. Twenty-four hours before admission he was seen for the first time by his doctor and was given 200,000 units of penicillin intramuscularly.

Examination on Admission.

Temperature 101°. Pulse 70. Right ear—post-auricular tenderness most marked over the region of the mastoid emissary vein. Slight post-auricular edema. Moderate degree of external otitis. There was a large central perforation of the tympanic membrane with a thin pulsating discharge, and a muco-purulent post-nasal discharge was present. There was no abnormality of the cranial nerves and no rigidity of the neck.

Operation I.

Performed shortly after admission. Post-auricular approach. Very sclerotic mastoid. Pus in small retrofacial and tip cells. Thrombosis of the mastoid emissary vein. Perisinous abscess. The lateral sinus did not appear to be thrombosed, but its wall seemed thickened as if containing a mural clot. Antrum opened, dura and sinus widely exposed. The wound was closed with steel wire and a thin rubber tube was inserted into the upper end for aspiration and replacement with penicillin solution.

Bacteriology.

Swabs taken from the perisinous abscess and from the mastoid cells were sterile on culture.

Post-operative Progress.

30,000 units of penicillin were given intramuscularly 3-hourly, and 1 gm. of sulphadiazine by the mouth 4-hourly for seven days. 100,000 units of penicillin were introduced *via* the tube three times daily for seven days. For a week after the operation the patient was well and afebrile. The post-auricular wound was healed by the seventh day, but a thick aural discharge continued. Penicillin and sulphadiazine were discontinued.

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E. H. Hadfield and R. T. Hinde

Between the seventh and twelfth days after operation this discharge increased and there was a steady rise in the pulse rate without fever.

On the twelfth day the patient developed a severe occipital headache with some signs of meningeal irritation. A lumbar puncture revealed no abnormality in the C.S.F. The pressure, Queckenstedt and Tovey-Ayer tests were normal. It was decided to reopen the mastoid and explore the lateral sinus.

Operation 2. 9.11.47.

The post-auricular wound was healed, but there was still a thick aural discharge, the mastoid cavity being filled with pus. The perisinous abscess had re-formed and was now extending almost to the jugular bulb. The lateral sinus was widely exposed and opened. There was a thrombosis of the lateral sinus consisting of an old mural clot with a central clot of more recent origin. The thrombus was removed. Packs were used to control the bleeding from the upper and lower ends of the sinus. When these were removed there was free bleeding from the upper end but not from the lower end of the sinus. The packs were replaced and the wound left open.

Bacteriology.

A swab of the operation site produced a moderate growth of anaerobic streptococci.

Post-operative Progress.

Systemic penicillin and oral sulphadiazine were recommenced. General improvement was noticed for four days, the patient was afebrile and there was only slight occipital headache and neck rigidity. A lumbar puncture again revealed no abnormality. For six days more the occipital headache persisted and was accompanied by a swinging temperature; mucopus was discharging freely from the post-auricular wound. On the tenth day after the removal of the clot from the lateral sinus it was decided once again to explore the mastoid cavity.

Operation 3. 19.11.47.

Performed twenty-two days after the first operation.

Extension of the original incision and removal of the bone to expose the jugular bulb and vein. There was an abscess extending alongside the lateral sinus to the jugular bulb. The jugular vein was collapsed but its wall appeared to be healthy. Evacuation of the abscess and closure of the lower four inches of the wound with steel wire stitches.

After this operation the persistent occipital headache disappeared and the patient became afebrile. The post-auricular discharge ceased and the wound was closed by secondary suture thirteen days after the third operation. The patient was sent home fourteen days later with a healed post-auricular wound, and with a central perforation of the tympanic membrane through which only slight discharge could be sucked. When he was seen again two weeks later this perforation had completely healed.

Clinical Record

CASE 2. Records No. 83902/48. Admitted 23.2.48.

History.

A boy of 15 was admitted to a fever hospital suspected of having typhoid. It was known that he had had a bilateral though intermittent aural discharge since infancy. No treatment other than sporadic and indifferent syringing at a school clinic had ever been undertaken.

Five weeks before admission the boy had complained of tinnitus in the right ear, but this passed off in two or three days. Two weeks later he suffered pain in the left ear but there was no discharge. He was given sulphonamide 1 gm. 4-hourly for three and a half days. The earache disappeared; both ears were dry. But for the next sixteen days before admission to the fever hospital the patient had a generalized headache, and a hard dry cough was declared.

Twelve hours later he was transferred to the Radcliffe Infirmary.

Examination.

The boy was poorly nourished, dehydrated, confused and flushed. He was, however, strikingly wakeful. T. 102°, P. 130, R. 56.

Left Ear. Postero-superior perforation pulsating and discharging offensive and thick mucopus.

Right Ear. A postero-superior pulsating point of light. Profuse offensive mucopurulent discharge.

Nervous System. Slight neck rigidity. Bilateral papilloedema of 1-2 dioptres. All limbs hypertonic.

Respiratory System. A pleural rub and harsh breath sounds at both lung bases.

23.2.48.

Hb. 51%. W.B.C. 8,000 per c.mm.

Chest X-ray. Bronchopneumonic appearances.

Mastoid X-ray. A few cells in both mastoids. All opaque.

25.2.48.

Lumbar Puncture. Pressure 160 mm. Jugular pressure on *right* failed to cause a rise of fluid in manometer; normal response on left. Fluid clear.

Protein. 15 mgm. per 100 c.c.

Chlorides. 660 mgm. per 100 c.c.

Sugar. Normal.

Cells. 4 per c.mm.

Culture. Sterile.

30,000 units of penicillin were given intramuscularly 3-hourly.

26.2.48.

In the evening a rigor occurred, the temperature reaching 105° F. A blood culture was taken. The pain in the *right* ear increased, and tenderness over the mastoid process and the jugular vein was noted. Sulphadiazine 1 gm. was given 4-hourly, and it was decided to operate upon the right mastoid.

Operation. Right Radical Mastoidectomy.

A large perisinous abscess situated between the lateral sinus behind and the facial ridge in front was exposed. A mass of cholesteatoma occupied the middle ear and extended into the antrum.

The lateral sinus was exposed from the mastoid tip to a point half an inch behind the upper genu. Its dura appeared paler than is usual, and near its lower end were a few red and apparently healthy granulations. Pulsation of the sinus wall was noticed. Digital pressure upon the sinus did not suggest the presence of a thrombus, and the sinus was not incised. The radical operation was completed, a meatal flap being cut. The wound was closed in its upper half and the cavity packed transmeatally.

Progress.

26.2.48. Immediate improvement in patient's condition. He was transfused with 525 c.c. of blood which improved his haemoglobin to 71%.

27.2.48. Condition less good. Seen by Mr. J. Pennybacker, who found no neurological abnormality save 1.5 dioptres of papilloedema.

Bacteriology.

Perisinous abscess, trachea and urine all grew *B. proteus* insensitive to 100 units/c.c. penicillin.

28.2.48. Temperature rose to 102° and dyspnoea increased during the day.

29.2.48. Early in the morning when it had been decided to explore the right lateral sinus, the patient suddenly complained of abdominal pain, became dyspnoeic and cyanosed. A large area of pleural friction at the left base had developed. It was decided to ligate the right internal jugular vein, but he quickly developed neck rigidity and, losing consciousness, died in four hours.

Post Mortem.

This showed a septic thrombus in the lower part of the right lateral sinus and internal jugular vein. Multiple bilateral lung abscesses had ruptured into the pleural cavities and there were bilateral infected effusions.

Commentary.

These cases are published in order to illustrate the dangers of placing too much reliance on the antibiotics and chemotherapy in cases of thrombosis of the lateral sinus.

At the first operation of Case 1 a thrombosed mastoid emissary vein was discovered, together with a perisinous abscess. There was, too, a suspicion that the sinus wall was thickened. Yet it was hoped that drainage of the extradural abscess with wide exposure of the lateral sinus would be sufficient to control the infection in the presence of local and systemic penicillin and sulphadiazine. It was assumed that the causative organisms were sensitive to these drugs, since a sterile culture from the perisinous abscess was obtained twenty-four hours after the drugs were first exhibited.

As has been described, this optimism was unjustified; operation on

Clinical Record

the lateral sinus became necessary, followed, on a later day, by drainage of a collection of pus around the jugular bulb.

Case 2 might have been saved had the lateral sinus been opened at operation.

When it had been decided to explore the right mastoid, more significance ought to have been attached to three clinical signs: the boy had a rigor; at lumbar puncture right jugular pressure failed to increase the spinal pressure; there was evidence of pulmonary infarction. But notwithstanding the discovery of a perisinous abscess and the presence of pulsation in the sinus wall, it was thought that the sinus did not contain a thrombus. Digital pressure and the presence of healthy-looking red granulations extramurally suggested this scepticism. Again reliance was placed upon antibiotics and chemotherapy.

As events showed, the sinus should have been opened and possibly the jugular vein ligated, the more so because the organism was insensitive to penicillin and sulphonamides.

These two cases seem to emphasize that where doubt exists about the established presence of lateral sinus thrombosis, it would be wiser to assume its presence and to act accordingly. Chemotherapy and biotherapy may assist in controlling the blood-stream infection where the organisms are sensitive, but these methods are an adjunct and not an alternative to surgical measures.

Acknowledgments.

Our thanks are due to Mr. R. G. Macbeth and Dr. A. M. Cooke, under whom these two cases were admitted to the Radcliffe Infirmary.

CLINICAL NOTE

INDIVIDUAL INSERTS FOR HEARING AIDS

By E. A. DENNISON, A. C. DEVERELL, T. S. LITTLER and E. WHETNALL
(London)

DURING the past eighteen months work has been carried out at the Deafness Aid Clinic of the Royal National Throat, Nose and Ear Hospital and at the Eastman Dental Clinic to find the most efficient and convenient method of making individually moulded inserts for use with insert telephone receivers. A number of tests have been made on various types of insert mouldings, both objectively (on an artificial ear) and subjectively. These tests show that the physical conditions necessary for a good acoustical communication from an insert receiver to the ear by means of a moulded insert are *very simple*. The cross section of the communication passage should be as large a bore as possible, and the surface of the bore should be smooth. It is also an advantage to have a solid plastic rather than a flexible one. Abrupt changes in the area of cross section of the bore should be avoided, and whenever possible the end of the bore where the nipple enters the meatus should be enlarged gradually so as to approach the area of cross section of the meatus over the whole circumference.

The tests also indicate that, provided the bore is of sufficiently large cross section, i.e. at least 3 mm., and provided the mould is a perfect seal in the meatus, the length of the bore is not critical. If the bore is less than 2.5 mm. cross section there is a definite loss of conductivity with the present forms of insert receivers. The portion of the mould entering the meatus need only be sufficiently large to ensure a secure fit and seal.

In general, insert receivers are clipped on to the moulds by means of a sprung ring, and a neoprene or thin rubber washer is used to complete the acoustic seal. It is very important that the mould surface should fit perfectly on the resilient surface and, to ensure this, it is important that this should be ground on a plane surface. Also, the spring in the retaining ring should be sufficiently tempered to maintain the good contact over a long period. If these precautions are not taken, not only is the maximum amplification of the hearing aid unobtainable due to feedback, but there is a possibility of distortion due to the shell of the receiver itself vibrating at certain resonant frequencies.

This article describes the method which has been found to be the most successful for making inserts which fulfil the conditions described. It is a modification of the method demonstrated at a meeting at the Institute of Laryngology and Otology in June, 1948.

The method is conveniently described in three stages :

- (1) Preparation of the Ear.
- (2) Taking the Impression and Casting the Model.
- (3) Fabricating the Insert.

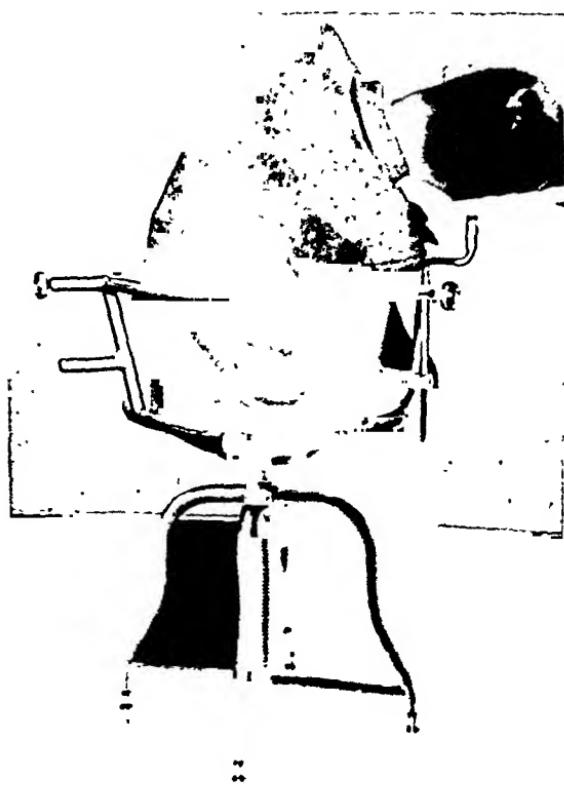


FIG. I.

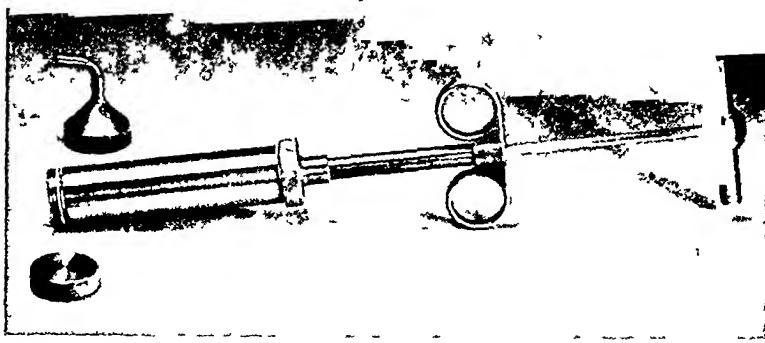


FIG 2.

Modification of the syringe used for de Trey's Dentocoll

Clinical Note

Stages (1) and (2) are carried out in the Otological Clinic, and Stage (3) in the Laboratory.

(1) PREPARATION OF THE EAR.

This should be carried out by a house surgeon, nurse or hearing-aid technician trained in the use of a head mirror. The meatus is cleaned free from cerumen. A small plug of wool is carefully placed near to the drum in order to protect it. The wool plug usually becomes embedded in the impression material when set and is removed with it. The practice of attaching a piece of thread to the wool has now been abandoned, as this thread is liable to mar the impression.

(2) TAKING THE IMPRESSION AND CASTING THE MODEL.

This stage of the work is carried out by a hearing-aid technician. The patient sits in the chair, as shown—a modified Bárány chair with adjustable headpiece (see Fig. 1). A dental napkin, slit in the middle, is used to prevent the impression material from coming into contact with the patient's hair.

It is considered that the most suitable impression material is Zelex Plus used with a retarding agent prepared by the makers of Zelex at our invitation. A normal mix of Zelex was found to be somewhat thick and a perfect impression was not always obtained, as air bubbles were liable to be enclosed. Zelex Plus can be used in a syringe (shown in Fig. 2), which has several advantages. The material can be mixed in the syringe, thus saving time, and it is then directed into the ear from the syringe while of such a consistency that it flows freely. In this way the problem of avoiding air bubbles is overcome.

The materials can be obtained ready dispensed in two containers, one holding the Zelex powder and the other holding the retarding agent.

The powder is placed into the syringe first and the retarding agent is then added. Mixing is carried out by moving the mixing plunger to and fro, and a smooth mix should be obtained in 30 seconds. A finger is used to close the nozzle of the syringe during mixing. The air must be excluded from the syringe before ejecting the impression material into the ear. This is carried

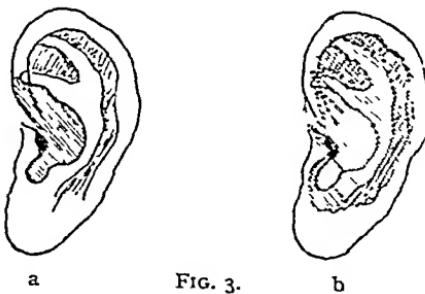


FIG. 3.

b

out by exerting pressure for a few seconds on the ejection plunger while keeping the nozzle still closed with a finger. Most of the air escapes round the plunger. The finger is then removed and any remaining air expressed. Although the finished insert will be only required to occupy the area shaded in Fig. 3a, it is advisable to cover the area shaded in Fig. 3b with the Zelex in order to facilitate removal. The impression is removed when a gel is formed, which should occur

in approximately 3 minutes. The wool plug is then cut off the tip of the meatal process if it is attached to the impression; otherwise it must be removed by the house surgeon or nurse.

Making Plaster Negative Mould.

An unfortunate characteristic of resilient impression materials is that they lose volume if left unprotected. The safest precaution is to cast the plaster model as soon as possible: within 5 minutes is a safe margin. It is important to realize that at a later stage the plaster is required to withstand heavy pressure and, therefore, a good quality plaster of paris must be used and the correct mixing technique applied. The plaster supplied by dental dealers is suitable for this purpose; rubber mixing bowls and spatulas can be obtained from the same source.

Mixing Plaster.—A sufficient amount of water is poured into the mixing bowl and then the plaster is sprinkled in until a shallow, dry mound appears above the surface of the water; this should be left undisturbed until the darkening shade and fissured surface denote that every particle of plaster has been saturated. It will then be found that with a minimum of spatulation a smooth, creamy mix is presented which will allow ample time for the work in hand before it becomes too hard.

Casting the Negative Mould.—Two methods are suggested to ensure the uniformity of the outer dimensions of the model: (a) When the plaster has been mixed it is spatulated into a rubber model-former into which the impression is settled until the working area is level with the rim of the model-former. (b) A waxed carton, similar to an ice-cream cup, may be used instead of the rubber model-former. It is important that the flat outer surface of the finished insert should be level with the rim of either the rubber former or wax carton, and therefore only the Zelex constituting the potential insert is immersed in the plaster. Some difficulty may be experienced in avoiding air bubbles in the plaster, but this can be overcome by painting liquid plaster on to the impression surface with a soft brush before immersing.

Since this impression is of a resilient nature, distortion will result if the impression is settled into plaster which has already become too stiff.

When the plaster has set sufficiently hard (about half an hour), the impression material should be prised gently out of the plaster, and in the case of (a) the rubber mould-former peeled away. The model is then labelled and is ready for despatch to the laboratory. In the case of (b) the waxed carton remains with the work throughout and has its identity registered by an embossed number, and it is necessary only to remove the impression material. The finished insert is returned in the waxed carton.

(3) FABRICATION OF THE INSERT IN THE LABORATORY.

At the laboratory, metal flasks are fashioned to hold one or more of the models received, but for the purposes of this description a small type flask which is large enough to contain only one model will be used.

Flasking.

Plaster is poured into the base of the flask, the model is soaked, should it have become too dry, and settled into the plaster. When the plaster is hard it is neatly trimmed flush with the metal rim.

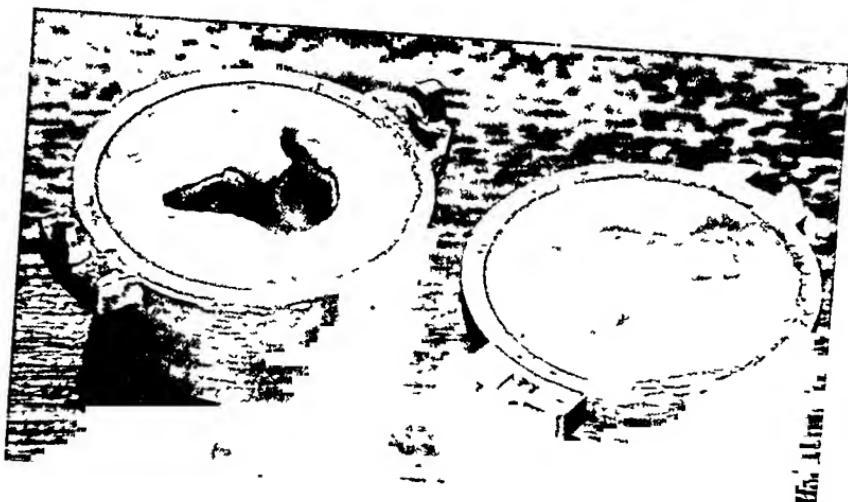


FIG. 4

Clinical Note

Waxing.

The cavity is filled with (dental) wax and this is trimmed level with the plaster. The plaster surface is smeared with a little vaseline. A reverse is then poured by filling the lid half of the flask with plaster and the two halves assembled and pressed together.

De-waxing.

When sufficient time has been allowed for the plaster to harden, the flask is opened and the wax washed out under a stream of boiling water (Fig. 4).

Packing.

When cool, the plaster surfaces are treated with one of the alginate solutions to form a protecting skin, or separating medium, between the acrylic resin and the plaster. The acrylic dough is prepared, and when a suitable consistency has been reached (i.e. when it will leave the sides of the mixing vessel quite clean) the required amount is placed into the cavity in the flask and pressure slowly applied. Closure of the flask should be spread over a period of five minutes in order to give the excess material time to "flow", and when closed the flask is locked in a spring clamp ready for processing. If crystal clearness is to be achieved, it is essential to process the acrylic slowly, otherwise there is a tendency to cloudiness and, what is more undesirable, there is a grave risk of porosity. The temperature should be raised slowly, so as to reach 70° C. in two to three hours, and it is maintained at this level thermostatically for a further minimum time of five hours.

Deflasking.

When processing is complete the flask is allowed to cool, and the plaster is removed to expose the insert. In the case of (b), the wax carton must be cleaned in readiness to hold the insert during the finishing stages.

Trimming.

The excess flash is trimmed away by means of special trimmers and stones while revolving in a small electric motor, and the insert is polished with pumice powder (wet) and finally with whiting.

Insert-ring.

A recess is now cut to receive the metal insert-ring and the hole drilled through the meatal projection. The path the hole must follow varies considerably with each insert and it will usually be found necessary to drill through from the "inner end" first until such a position is reached that when an approach is made from the outer surface the two holes will meet. The insert-ring is now warmed and settled into the recess previously prepared and the split-ring retainer is clipped into the insert-ring.

We are indebted to Mr. D. R. McDougal, photographer to the Eastman Dental Clinic, for the photographs.

SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY

December 3rd, 1948

President—E. COWPER TAMPLIN, M.C., F.R.C.S.Ed.

Submucous Rectification of the Nasal Septum

By H. V. FORSTER

THE operation of submucous resection of the nasal septum which I was taught to associate in its full development with such names as Killian, Ballenger and Freer, appeared to owe its success in establishing a wider nasal airway to the actual removal of those parts of the cartilaginous and bony frame which were deformed, though leaving enough support to prevent a subsidence of the bridge or roof of the nose. From the results which one sees from time to time I conclude that this tradition is still followed.

For many years operating by the submucous method, I have attempted to correct these deformities rather than remove them. In Sir StClair Thomson's book, *Diseases of the Nose and Throat*, 1926, 3rd edition, New York, the author states that for the previous fifteen years he had replaced most of the broken-up septum, the pieces being left lying between the mucosal flaps during the procedure. The resected cartilage was then divided into pieces to fit like a mosaic into the window made in the septum.

I had often wondered whether a difficulty here would be that as the wall of the middle partition of the nose was being rebuilt some pieces might fall down again before suitable packing had been put in to give them support. If this were a real difficulty then it might be avoided, as it appears to be by Cottle and Loring (1948), who put vaseline gauze into the nasal passages before rebuilding the wall. The mucosal flaps are then separated again by the long speculum and reconstruction is begun.

In these operations I prefer to use local surface anaesthesia, except for the few who call for a general anaesthetic, and in children where I proceed to interfere with less anxiety than formerly because of the use of a conservative method. In many cases the final objective is to uncover, isolate and often remove that deformity which we might call the ethmo-vomerine knuckle. This will be found to have a constant companion likewise deformed, the small processus sphenoidalis septi cartilaginei, but in making the advance it should be possible to turn aside, rather than remove, the greater quadrilateral cartilage and dispense with that ingenious instrument, the swivel knife of Ballenger.

The cartilage is separated from the nasal spine and from the vomer which so often carries a shelf or spur, and next from the vertical leading edge of the ethmoid plate, and is then turned aside.

Royal Society of Medicine

The ethmo-vomerine knuckle is uncovered, and at times it may be convenient to restore it to a median position though more often to isolate and remove it, either before or after reducing any bony shelf already uncovered in the advance.

In removing some spurs or when dealing with the nasal spine it is not necessary to upset their bony foundations but to thin them laterally with the chisel or gouge, and in working here I like to have the assistance of a "third hand" to wield the mallet with such force as the operator directs, the assistant accepting the role of "blacksmith's striker".

At times one may correct these basal deformities by fracture and so retain much of their substance.

It may be asked whether in separating vertically the quadrilateral cartilage from the ethmoid plate, there is a risk of holing the underlying mucosal covering, but I do not find this a real hazard, and I am prepared to arrive at this stage of the operation after working beneath the muco-perichondrium of one side only.

Another question might be, may not the spring-like plate of cartilage tend to return to its original position? But freed as it is now in front, below and behind, it is amenable to direction by such adjustments as may be made by the ingenuity of the operator. If by chance a tear has been made in the unsupported area of mucosa below, we have a reserve at hand from which a piece may be cut and dropped into the gap.

I would not claim that it is always possible to preserve the whole of a deflected ethmoid plate, but much can be done by fracture or division to bring it into the mid-line. If we turn next to the problem of the columella which has been deprived of support by a deflection of the free edge of the cartilaginous septum, one is faced with special difficulties; but at times one is able to persuade the free edge to enter a pocket cut in reverse beneath the skin of the vestibule. These difficulties are discussed in the recent article by Cottle and Loring.

In conclusion I would say that in performing a more or less conservative operation within the nasal septum one has the satisfaction of preserving much of its structure and the result is kinder to its mucosal covering.

Perforations are less likely to follow submucous rectification than after resection, and recently I saw a perfect example of the "flapping" septum after the latter operation. I was at a loss to suggest a suitable remedy for this post-operative inconvenience, but it is one which should not follow the more conservative routine.

It has been suggested that fibrous tissue may develop in the membranous middle partition of the nose after resection of the skeleton, and that there might be a tendency for it to pull down the beam which has been retained beneath the roof, with the result that in time the profile may change; but preservation of the skeleton should offer strong resistance to the pull of fibrous tissue, and at best some may form in the scar of the original incision whichever method is used.

The relatively larger inferior turbinate body in the wider side of the nose should be fractured and displaced laterally rather than sacrifice any part of it. This important body regulates the volume of air admitted to the nose, and its surface represents a wide area. The importance of the relationship of surface

Societies' Proceedings

area to the capacity of the nasal chambers will not be questioned, for their air-conditioning function comprises cleaning, moistening and, in these latitudes, warming the stream which eventually finds its way to the lungs.

When we think of the ciliated epithelium which lines these surfaces it is encouraging to recall the opinion expressed by Dr. Arthur Proetz (1948) that the individual cilia have greater powers of resistance than perhaps had been realized.

In performing operations on the nasal septum, therefore, let us proceed kindly and do our best to retain a firm base of operations for these minute but sturdy elements whose duty it is to remove those impurities from which a healthy nose should protect the lower respiratory tract.

REFERENCES

COTTLE, MAURICE H., and LORING, ROLAND M., 1948, "Surgery of the Nasal Septum," *Ann. Otol., Rhin. and Laryng.*, lvii, 705.

PROETZ, ARTHUR W., 1948, "Recent Progress in Nasal Physiology," *Proc. R. Soc. Med.*, xli, 793.

MR. H. V. FORSTER said, in reply to discussion, that when a general anaesthetic was demanded the rebreathing through a wide-bore laryngeal tube with closed circuit provided a sense of security to the operator, but in spite of added local anaesthesia and ischaemia, he had found there was more congestion and the need for more frequent mopping of blood from the field of operation.

He preferred a local surface anaesthetic alone, and most patients were agreeable to its being used.

He appreciated Mr. Layton's support in the conservative treatment of the inferior turbinate.

Osteomyelitis of the Frontal Bone of Rhinogenic Origin

By RONALD G. MACBETH

OSTEOMYELITIS of the skull may occur wherever there is diploetic bone in the neighbourhood of an infected air-sinus. Consequently, the frontal bone is by far the most frequent site, with the maxilla next in frequency, while the ethmoid and sphenoid are only rarely involved.

While it is convenient to consider the acute and chronic conditions separately because of their different clinical manifestations, it is generally agreed that the chronic form is pathologically an extension of the acute. In the chronic, however, reparative processes are outrunning destruction.

A. ACUTE OSTEOMYELITIS

This condition may occur spontaneously as a sequel to untreated sinusitis of acute or acute-on-chronic type, or it may follow operations upon the sinuses. The material collected and published by different observers gives contradictory evidence as to the relative frequency of these two classes of case, though the warnings in most published work and textbooks about the dangers of operations



FIG 1

This photomicrograph illustrates a relatively acute osteomyelitis of the frontal bone in the established phase (actually of traumatic causation). The marrow space is filled with round cells and fibroblasts, and there is a considerable area of granulation and exudate near the left upper corner. Towards the right lower corner there is a bony partition showing erosion by osteoclasts, and this is in the process of becoming a sequestrum ($\times 230$)

Royal Society of Medicine

lead one to suppose that, as a whole, rhinologists are more conscious of the post-operative group. Figures are possibly further clouded by the fact that cranial osteomyelitis may occur after quite trivial operative measures—such as removal of an ethmoidal polypus—not normally classified as operations. It is probable that in the cases occurring after operation there is a pre-existing spread of infection.

Etiology.—This disease occurs most frequently in children and young adults. There would appear to be a predilection for the female sex, but this is probably unimportant.

Pus under pressure in the sinuses, and without drainage, is the main aetiological factor.

Recent freshwater swimming and diving are often elicited as predisposing factors in the history of spontaneous cases.

Scarlet fever, erysipelas, and acute infective fevers are thought to predispose to the less acute forms of osteomyelitis of the skull.

Finally, to explain why some patients do and others do not develop osteomyelitis in identical circumstances, one must invoke the imponderable general factors of high virulence of the infecting organisms, and low resistance of the patient's tissues. A low vitamin level, particularly of vitamin C, may possibly contribute to this low resistance.

Bacteriology.—The same organisms commonly found in sinusitis are implicated in this disease, but *Staph. aureus* and anaerobic streptococci account for most of the cases. The haemolytic streptococcus, pneumococcus, and *H. influenzae* are also found. This last is more likely to be associated with a circumscribed subacute lesion. In addition, records of two cases by the *S. typhosus* have been found in the literature,⁹ but it is possible that these may have been metastatic in origin.

In the ten-year period 1937-46, there were admitted to the Radcliffe Infirmary, Oxford, 37 cases of osteomyelitis of the skull bones, of which 29 were attributable to sinusitis; and of these latter bacterial records are available in 23 cases:—

Staph. aur. 9, *Anaerobic strep.* 8, *Staph. albus* 1, *Haemolytic strep.* 2,
Sterile 3 cases.

The comparatively frequent occurrence of an anaerobic streptococcus is of the greatest possible importance. Unless special anaerobic cultural methods are employed it is apt to be missed, and a sterile report is recorded. Furthermore, such anaerobic (or micro-aerophilic) streptococci may be relatively resistant to the sulphonamides and to penicillin, and it is evidently important in all cases to have a report upon the sensitivity of the infecting organism to these drugs.

It has been found by Cairns³ that the culture of the bone in these cases does not always correspond with that of the implicating sinuses, anaerobic streptococci being sometimes found in the bone while *Staph. aureus* is found in the sinus. In such cases the probability is that the staphylococcus is a secondary invader. Galloway⁶ has noted that anaerobic and micro-aerophilic streptococci are often found in association with infections about the head.

Societies' Proceedings

Pathology.—The main pathological fact in both the spontaneous and post-operative groups of cases is infection of the diploic space. In the former group, the pathological process involved must in the earlier stages be a matter for conjecture, because material has not been available for examination; but it seems very likely that there occurs a thrombo-phlebitis of the veins of the sinus mucosa, and that this extends by direct spread into the diploic veins. This would seem to be a rational event. Further, in established cases, venous thrombosis is found in the diploe in advance of the spreading lesion.

In the post-operative group, it is easy to assume that direct instrumentation may let micro-organisms into this space, and no doubt this occurs in some cases. In others, however, where the diploetic bone is not directly opened, this facile explanation will not hold. Such are cases where the frontal sinus has been opened *via* its floor, and where frontal osteomyelitis followed ethmoidal polypectomy or operations upon the maxillary sinus. In these cases, it must be assumed that disturbances in the near-by nasal region determine a temporary decrease in the drainage of a co-existent frontal sinusitis and therefore a commencing venous thrombo-phlebitis in the diploetic bone.

Wilensky in his review of the subject in 1932¹³ divides the gross pathology into four stages: (1) The earliest when nothing can be seen by the naked eye. (2) Hyperæmia of the diploe with droplets of pus. (3) Medullary granulation tissue, and obvious thromboses. (4) Para-osseous abscess formation on both sides of the bone, and sequestration.

Thereafter the disease ceases to be localized to bone.

Kos⁸ has made microscopic studies of the sequences occurring in the marrow. The earliest change noticed is dilatation of the vascular channels and invasion by organisms and round cells. This is followed immediately and rapidly overshadowed by hyperplasia of the marrow cells. The next state is thrombosis in the vessels, leading to broken masses of fibrin and débris resembling a "log-jammed stream". The marrow spaces are replaced by granulation tissue, osteoclasts then appear and erosion of the bony partitions begins. Osteoblastic activity occurs between the inner table and the endosteum, and some new bone-formation begins along the dural surface. Finally, fibrosis occurs around the marrow elements.

Kos notes that these processes tend to shunt the infection towards the dura, and hence that intracranial complications may be expected. He concludes that the microscopic picture justifies radical treatment.

In the really acute cases there is only slight regenerative tendency, and this occurs mainly in the periphery and superficially on both sides. The dura mater is affected late, and is able to isolate large collections of extradural pus for a considerable time before invasion occurs.

In some cases, the spread of infection in the frontal bone seems to be subperiosteal and in the outer layer and this is true of the less fulminating types of disease. But Furstenberg⁵ has noted in autopsy specimens that the inner plate of bone is often destroyed first. He points out that the arterial supply and venous return of the bone occur *via* the dura, which he regards as the physiologically effective periosteum. He also emphasizes the well-known fact that the first outward sign of the disease may appear superficially on the frontal region, a measurable distance away from the primary lesion in the sinus.

Royal Society of Medicine

He regards this observation as evidence supporting the idea that the osteomyelitis spreads by thrombophlebitis, which latter process may be partially metastatic and then retrograde in its spread.

Caussé,⁴ on the other hand, challenges this conception and, on the basis of the histological examination of four cases, suggests that the main mode of spread of the infection is *via* the Haversian canals. He thereby readily explains the appearance of isolated subperiosteal swellings, and regards the thrombophlebitis as incidental.

Once it has begun, and unless treatment be instituted, the inflammatory process tends to spread in the diploe. The suture-lines have little or no isolating function because there are large venous connections across these, *via* which the inflammation spreads still further.

The more acute the condition, the greater is the tendency for it to spread, and the less the tendency towards regeneration. At the other end of the scale is the type which starts as a localized acute condition, and it is probable that it will become the commoner type clinically, because of the almost universal practice by family physicians of giving sulphonamides in small dosage for sinusitis.

Symptomatology and diagnosis.—The onset of the disease, in the spontaneous cases, usually occurs a few days after the underlying sinusitis has become established. Similarly, the post-operative cases begin a few days after the operative intervention. The first complaint is often of headache, either generalized or occipital in type, and worse at night. This change in the character of the head-pain in the absence of meningeal signs should be regarded as significant.

The temperature often rises at this time and there may even be a rigor. Thereafter pyrexia is variable, and it must be remembered that it may be masked by coincident chemotherapy.

The patient then usually notices a swelling over one frontal bone, or both bones, and this may, in fact, be the first manifestation of trouble. If, as is probable, sulphonamides have already been given, this swelling may arise quite painlessly. It is usually situated 2-3 cm. above the eyebrow—i.e. above the uppermost limits of the frontal sinus (see Fig. 2).

Initially the swelling is "doughy" and tender, and evidently subperiosteal, but in a few days it becomes soft and fluctuant, because pus has formed. Later, this bursts into the subcutaneous tissue, and at this stage the patient's pain may become less marked. The upper eyelid may or may not be swollen as a result of the underlying disease or operation, but if not it gradually becomes so. In post-operative cases, the scar becomes reddened and elevated.

Endonasal examination shows the signs of sinusitis or operation, or both.

Epileptiform attacks may occur because of extradural abscess, cerebral thrombosis, or abscess, and are an urgent indication for surgery.

Radiography in the first seven to ten days will show no changes in the bone, but thereafter a mottling appears in the P-A. and lateral views, with an area of impaired translucency in its periphery. The diagnosis, however, should be made before radiographic evidence is positive.

The clinical course of the disease from this time depends upon what treatment is given, but it may be mentioned here that unless vigorous steps are

Societies' Proceedings

taken, there is a disappointing tendency for the condition to relapse and to progress. Reference will be made again to this point under the heading of treatment. In the untreated cases the area of oedema spreads, the patient begins to suffer from pyæmic invasion of the blood-stream, and death may result from infection of the brain or lungs.

Complications.—The commonest complications of severity—apart from those forming part of the generalized septicaemia—are pachymeningitis and abscess of the brain. The superior longitudinal venous sinus is often thrombosed at an early stage, and the thrombo-phlebitic process may readily extend to the cerebral veins. In a review of 23 cases of purulent pachymeningitis arising from sinusitis, Cairns found that there was osteomyelitis of the skull in 19 cases: extradural abscess, 12; sinus thrombosis, 4; cerebral abscess, 3; severe leptomeningitis, 6; pulmonary abscess, 2.

TREATMENT

(a) *Prophylactic.*—Where operations on infected sinuses are undertaken, it has been found that the post-operative progress is freer of incident, healing is more rapid and the temperature is controlled, if a full course of appropriate sulphonamide be given to the patient commencing on the day before operation. By this means, the patient is protected adequately and post-operative osteomyelitis is prevented, providing that the infective organisms are sulphonamide-sensitive. It is, therefore, important to culture all nasal flora before operation and to determine their sensitivity. Penicillin can obviously be used systematically in place of the sulphonamides as a prophylactic, but it is probably wiser to retain it for use in those cases in which complications are feared, and for the worst cases of acute frontal sinusitis.

The immediate treatment of the acute case of frontal sinusitis which did not settle down upon conservative measures has always been controversial. It was insisted by many that operation upon such a case was highly dangerous and very likely to lead to osteomyelitis. More recently it has been held that minimal external drainage is the safest treatment. Without embarking upon this controversy, it may be said that if penicillin be used locally, and sulphonamides given by mouth, a minimal external drainage *via* the floor of the sinus may be made with safety, and that this is now the method of choice. The general principle of allowing pus to escape is thus maintained, and the risk of thrombo-phlebitis is minimized.

Technique.—A small incision is made below the eyebrow and medial to the inner canthus. A dental cutting burr is used to remove a small piece of the floor of the sinus, the pus is sucked out, and a piece of fine rubber tubing is inserted. The wound is sewn up and the tubing allowed to project through the bandage. Twice daily the sinus is emptied by suction and 1 c.c. of saline containing penicillin 10,000 units is injected. After two or three days the penicillin usually appears at the nostril, showing that the duct has re-established patency.

(b) *Active.*—In the past, it had been realized that simple incisions of subperiosteal abscesses, and local removal of bone, had done no more than give the patient temporary relief. The disease progressed insidiously and the

Royal Society of Medicine

surgeon was led on from operation to operation, until much of the cranial vault had been removed, and in the end, in most cases, the patient succumbed to general septicæmia or meningitis.

It then became evident that the only chance of curing a patient suffering from this disease was early and wide removal of the affected bone, together with a surrounding area of healthy bone. After the adoption of this principle, surgeons began to report occasional successful cases.

The advent of the sulphonamide group of drugs, it was hoped, might lead to a cure of this disease without recourse to severe operations. But experience here was parallel with that gained in the treatment of osteomyelitis elsewhere—namely, that these drugs might have a beneficial prophylactic action and might combat the general spread of the sepsis, but that they had little or no local effect upon the established case. Further, it was soon realized that the administration of these drugs—particularly in half-hearted dosage—might even mask the symptomatology; and that the infecting organisms might become resistant at a time when the drug would be most valuable, namely when radical operation was contemplated. It behoved surgeons, therefore, to treat their established cases by radical surgery as before, and to keep the sulphonamides as a valuable adjunct in the pre- and post-operative phases.

When penicillin appeared it was once more hoped that cranial osteomyelitis might be cured without operation. This proved to be only partly true, and a successful case is described below. Putney,¹¹ in a survey of the value of penicillin in otolaryngology in 1944, states that very early cases of acute osteomyelitis may be arrested and cured by penicillin therapy, but that its main use in established cases is to cause localization of the disease and reduction in the amount of bone ultimately needing to be removed at craniectomy. With this view most surgeons who have used penicillin intelligently would agree, and it is consistent with experience gained in the treatment of osteomyelitis in long bones.¹² Hall⁷ has also reported early cases successfully treated without removal of bone, but agrees that the main role of penicillin is to make surgery minimal and safe.

It is probable that streptomycin and other antibiotics will also come to play a valuable part in treatment.

The sulpha drugs and antibiotics have reduced the incidence of osteomyelitis of the skull, enormously diminished the death-rate, and caused operations to be more limited.

It is felt that the method of treatment of the established case should be as follows :

(1) Commence three-hourly penicillin therapy and full sulpha-drug dosage. It is doubtful if more than 20,000 units of penicillin need be given at a time, but it may also be argued that because of the existing vascular thromboses, a larger dosage of 50,000 is advisable. Take a swab from the affected side of the nose, and ask that the sensitivity to penicillin be determined. This may influence the dosage.

(2) Drain the frontal sinus by a small external incision and burr-hole in the floor as described above.

(3) Maintain the penicillin and sulpha-drug dosage for five days, and watch

Societies' Proceedings

the progress of the disease clinically and by X-ray. If the swelling be diminishing, the systemic penicillin may be reduced to 100,000 units eight-hourly, and the local penicillin probably can be discontinued altogether. Should the patient continue to make progress, after about two weeks he can be allowed to leave hospital, but he should continue to receive penicillin 100,000 units twice daily for another two weeks, either as an out-patient or from his family doctor. Thereafter, he is X-rayed, and the examination is repeated monthly. It must be emphasized that at the slightest suggestion of relapse he must return into hospital.

(4) If the lesion continues to spread, or—though localized—does not disappear, and if the X-ray shows no improvement, operative removal of the diseased area must be undertaken.

Operative technique.—The head is shaved and an incision is made through the scalp from one pre-auricular region over the vault to the other. The deep layer of the scalp is picked up with fine artery forceps and superficial bleeding thus brought under control. Burr-holes are made through healthy bone about 2 cm. peripheral to the obvious disease, and are joined by means of a Gigli saw. The main mass of diseased bone is then removed. Any doubtful areas of diploic bone are nibbled away, and the bone removal is carried anteriorly to the lowest limits of the frontal sinus or sinuses, and the anterior ethmoid cells are opened.

The dura mater is carefully inspected for necrotic areas, its surface is dusted over with sulphonamide powder mixed with penicillin, and the scalp is sutured. Although drainage may not be necessary, it is probably wisest to insert corrugated rubber drains through the extreme ends of the incisions and leave them for twenty-four hours. Blood-loss may be severe and a transfusion may be needed.

Usually healing is *per primam*, but if small sequestra make their appearance, these can be removed locally as required.

ILLUSTRATIVE CASES

CASE 1.—D. D. (Case No. 70,408/48), a male aged 27, admitted to the Radcliffe Infirmary on 30.3.48, with a tender swelling over the right eye (see Figs. 2 and 3).

History of pain over right eye for about two months, after an acute upper respiratory infection. Subacute infection of the right frontal sinus was confirmed by X-ray on 26.2.48 and patient was treated by shrinking drops and penicillin suction displacements. His symptoms improved, but the pain recurred and swelling appeared on 29.3.48. X-ray showed an area of osteitic rarefaction in the right frontal bone.

Treatment.—He was given penicillin 50,000 units three-hourly and sulpha-triad in full dosage, and these were maintained for six days. On 31.3.48 the right frontal sinus was drained externally under local anaesthesia and penicillin irrigation tube was inserted and sewn in place. Yellow pus was found under pressure, a swab from which showed anaerobic streptococci on culture. The right antrum was punctured and washed out. After six days the penicillin



FIG. 2.

Showing how the main swelling in acute cases tends to appear 2-3 cm. above the eyebrow. This patient had had his sinusitis for four weeks before the osteitic signs developed. The infecting organism was an anaerobic streptococcus.



FIG. 3.

Shows the patient's final appearance after external drainage of the right frontal sinus, and penicillin therapy.

Case D.D. Figs. 2-5.



FIG. 4.
Shows condition before drainage of sinus.

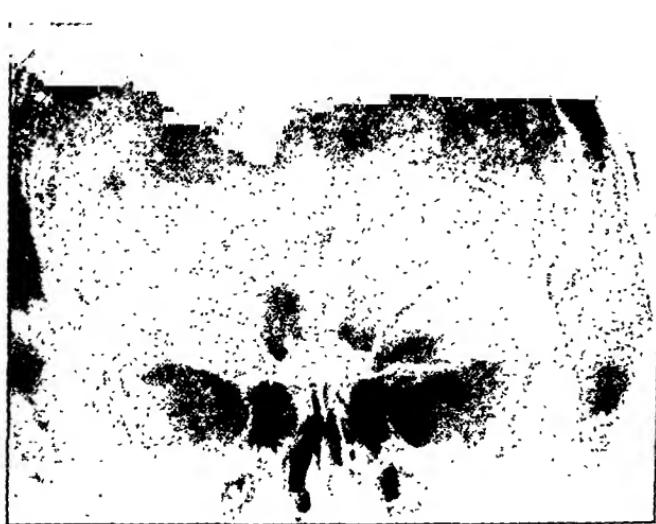


FIG. 5.
Shows condition nine months after drainage of sinus. (Figs. 4 and 5.—Serial skiagrams illustrating progress of case D. D.)

CASE D. D.—FIGS. 2 to 5.



FIG. 6.

Skiagram of the established quiescent but uncured osteomyelitis in August, 1945



FIG. 7.

Shows condition three months later, bony sclerosis—i.e. chronic osteomyelitis of secondary type (see p. 623).

Case A.D. Figs. 6-12.



FIG. 8.
Showing the bony defect after craniectomy.

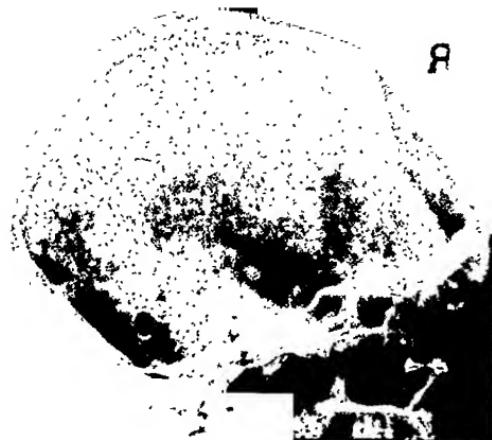


FIG. 9.
Showing the bony defect after craniectomy.



FIG. 10.
Shows very slight regeneration of bone after fourteen months.

Royal Society of Medicine

was given in doses of 100,000 units eight-hourly. The tube was removed from the frontal sinus after seven days.

He left hospital on 15.4.48, free of all symptoms and with the frontal swelling completely gone. He continued to receive penicillin 100,000 units b.d. for a further two weeks, and was X-rayed monthly. The skiagrams showed progressive improvement (Figs. 4 and 5).

Comment.—This is an early case of frontal osteitis successfully treated by simple drainage of the causative lesion, together with systemic and local penicillin, and sulphatriad in full dosage.

CASE 2.—A. D., a female aged 19, admitted to the Radcliffe Infirmary on 8.8.45, with a tender swelling in the centre of the forehead.

About the middle of June, 1945, she began to have severe frontal headaches, worse in the morning. These commenced a few days after swimming and diving in the Thames at a popular bathing place. A few days later still, the left eyelid swelled (June 23rd).

She was treated at Windsor by Mr. A. C. Maconie as a case of pansinusitis, given sulphadiazine, and the left antrum was punctured and washed out three times. After three weeks she was better and complained of nothing relevant until August 5th when a tender swelling occurred centrally in her forehead. Penicillin was given in Windsor Hospital three days, then she was transferred to Oxford.

Clinical examination at that time showed some degree of sinusitis on the left. The C.N.S. examination was negative. X-ray showed impairment of translucency of the left frontal, ethmoids, and antrum, but no changes in the diploe of frontal bone. Penicillin therapy was continued at a dosage of 20,000 units three-hourly.

12.8.45. Left frontal sinus was opened externally through a minimal incision, pus was found under pressure. A small tube was introduced and penicillin solution (10,000 units) was instilled twice daily. Bacteriological reports showed *Staphylococcus aureus*. On 16.8.45 penicillin solution began to flow down the fronto-nasal duct, so the tube was removed.

21.8.45. Left antrum was punctured and washed out, and found almost clean. The swelling had ceased to be soft and oedematous and had become much smaller and hard. Penicillin was discontinued and after consultation with Mr. Joe Pennybacker she returned home a week later, apparently controlled, and possibly cured. X-ray at this time showed some erosion and mottling of the frontal bone (Fig. 6).

7.11.45. She was very well. X-ray still showed the irregular mottling of the bone and considerable sclerosis (Fig. 7).

17.2.46. A painless swelling occurred over the left frontal bone. There was no precipitating nasal infection. She returned to Oxford on 20.2.46 and was given sulphadiazine and penicillin once more.

23.2.46. In view of the history and the unchanged X-ray findings, removal of the diseased bone was undertaken by Mr. Pennybacker through a coronal incision. Some granulation was seen superficially. The whole block of bone was removed to reveal its under-surface "worm-eaten", and purulent granulation tissue covering the dura mater. A diploic channel filled with granulations

Societies' Proceedings

connected the left frontal sinus with the diseased area, and was presumably the route whereby the infection had spread to the bone (Figs. 8, 9).

Superficial healing was uneventful, and she suffered no complications.

She regenerated hardly any new frontal bone, therefore on 23.5.47 a tantalum plate was made and inserted to fill the frontal defect (Figs. 10, 11, 12).

Comment.—This was a case treated successfully; initially by a combination of conservative surgery and penicillin, and later by radical removal of the diseased area. The penicillin therapy enabled the patient to localize the infection, but did not cure it. The case was converted from one of acute osteomyelitis to one of secondary chronic infection.

PROGNOSIS

If the disease is recognized early and treated by a combination of chemotherapy, antibiotics, and operation, the outlook for the patient's recovery is good. In general, the more fulminating the disease, the worse is the prognosis; but even where septicaemia or intracranial suppuration has already occurred, and provided that the organisms are sensitive, the expectation of a cure is reasonable.

SEQUELAE

(a) *Local.*—The operation wound usually heals *per primam* and the patient is left with a large bony defect, through which the cerebral pulsation may be seen and felt. In cases where the dura mater has not been injured, nor its vitality impaired, new bone-formation may begin in the first months after operation. At first, irregular whorls of compact bone are laid down, which may be partially mobile, but later the defect is completely bridged and assumes the characteristic shape of the calvarium. Furthermore, in children, frontal sinuses whose outlines were destroyed at the operation sometimes re-develop. Younger patients are more likely to show this regenerative power than are older, though Furstenberg⁵ reports complete repair in a patient aged 46.

ILLUSTRATIVE CASE (FIGS. 13 to 17)

F. C., a girl aged 10 years, admitted to the Radcliffe Infirmary on 26.11.41 with symptoms and signs of acute right frontal sinusitis.

History.—Nine days previously developed a head-cold, then a frontal headache began and five days previously right upper eyelid began to swell.

On admission: Sulphathiazole 3 grammes, followed by 1 grammme four-hourly.

27.11.41. Right antral puncture—lavage produced pus. Immediately patient had an epileptiform attack, violent convulsions mainly on left side, with loss of consciousness. Controlled by pentothal 0.2 grammme intravenously. Right frontal sinus opened later and drained *via* floor.

Bacteriology.—*Staphylococcus aureus*.

29.11.41. Oedema over sinus diminished; frontal bone slightly tender. Neurological examination negative. Lumbar puncture normal.

1.12.41. Fluctuant swelling in mid-frontal region. X-ray showed osteitis right frontal bone (Fig. 13). Operation *via* bitemporal coronal incision. Superficial abscess over area of roughened bone 5 cm. in diameter, mainly on



FIG. 11.

Shows patient's appearance in May, 1947, immediately prior to implant of tantalum plate.



FIG. 12.

Shows her appearance two months later.

CASE A. D.—FIGS. 6-12.





FIG. 13

A skull X-ray taken before operative removal of frontal bone, December, 1941.



FIG. 14.

One of a series of X-rays showing gradual development of new bone over forehead.

Case F.C. Figs. 13-17. see p 624.



FIG 15
Photograph of patient in 1943.



FIG 16

Skiagram taken 1944 Note complete regeneration of bone and enlargement of anterior ethmoid cells to replace frontal sinuses

Royal Society of Medicine

right side. Bone removed widely; frontal sinuses and ethmoids opened anteriorly. Extradural abscess found under the necrotic bone. Skin sutured with lateral drainage at both ends of incision. 6.12.41: Given a blood transfusion. 8.12.41: Right intranasal antrostomy. 3.1.42: Went home.

Subsequent progress.—Had occasional headaches, and on several occasions minor puffiness of right eye. No nasal symptoms.

Serial X-rays showed gradual development of new bone over forehead (Fig. 14) and some regeneration of frontal sinuses.

Photograph (Fig. 15) taken 27.3.43. Last seen 21.6.44; very well (Fig. 16).

Fig. 17 shows the temperature and pulse chart of the illness.

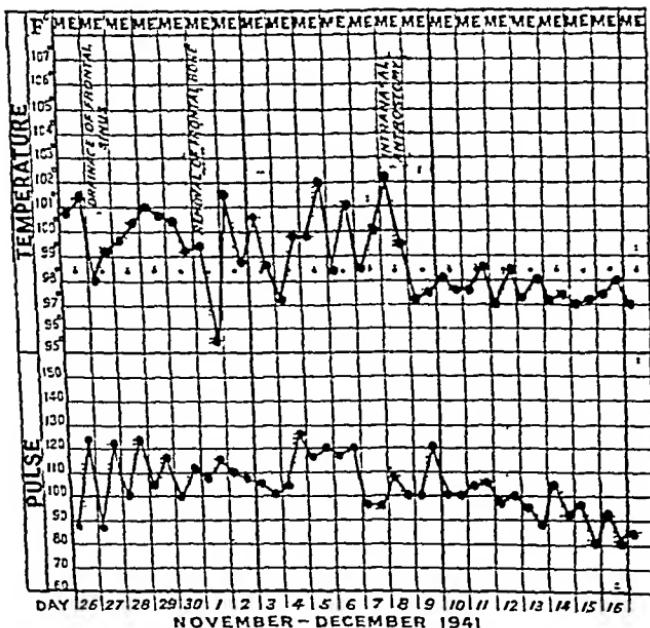


FIG 17

(Case F C) Patient treated by surgery before penicillin was available
CASE F C—FIGS 13-17

Occasionally small sequestra separate weeks or months after the primary operation, and these may produce small localized abscesses, whose treatment needs no comment.

Where the patient fails to repair the bony defect spontaneously, it may be necessary to insert a plate of tantalum or acrylic resin, as in the case of A. D., described above.

(b) *General.*—Cranial surgeons have reported epileptiform attacks as a long-term sequel to successful treatment of acute osteomyelitis of the frontal bone. Where these occur, it is evidently always necessary to exclude an abscess of the brain. It is recommended that patients who have had a resection of

Societies' Proceedings

skull should be given a maintenance dose of phenobarbitone for at least six months post-operatively.

B. CHRONIC OSTEOMYELITIS OF THE SKULL

Brunner^{1, 2} has published a series of cases. Maxwell¹⁰ has pleaded for a recognition of the condition as a clinical entity and described a further series in 1946.

Aetiology.—The aetiology may vary considerably, but this article is concerned only with such cases as may arise from sinusitis. Chronic osteomyelitis of the skull may arise *de novo* (the commoner type), or secondarily as a quiet continuation of acute osteomyelitis. For the rest, the same factors are concerned as are relevant in the acute condition.

Bacteriology.—In the secondary type, the same organisms occur as are found in the acute disease. In the primary type also *Staph. aureus* and *Strep. haemolyticus* are commonly found, but often there is a negative culture. This negative finding suggests that possibly in some cases an anaerobic streptococcus may actually be responsible, but that it has been missed because appropriate cultural methods have not been adopted.

Pathology.—As has already been noted, osteoporosis and osteogenesis proceed concurrently in all forms of osteomyelitis. In the more acute cases the virulence of the infection is relatively high and the blood supply relatively good, consequently osteoporosis predominates. In the more chronic cases the reverse is true. The blood supply is gradually cut off by a process of thrombosis and endarteritis, and consequently osteogenesis and calcification ensue.

Maxwell¹⁰ has shown that excised normal frontal mucoperiosteum, if transplanted into the lumbar musculature of experimental animals, is capable of producing new bone. It is reasonable to suppose, therefore, that bony thickening occurs immediately subjacent to any chronically infected sinus mucosa. This probably leads to the types of obliterative sinusitis described by various authors. There is, indeed, no clearly established pathological differentiation between this type of thickening of the bony walls of the sinuses, osteitis fibrosa, and true osteoma formation.

It would seem that in common sinusitis the bony thickening is not of clinical significance, but when micro-organisms penetrate into the marrow spaces, a spreading chronic proliferative osteomyelitis may be set up. In the more chronic primary cases, the spreading process results in fibrosis of the marrow spaces and a more or less smooth healing; in the less chronic secondary cases, osteophytic processes assume the irregular shape of the parent granulation tissue. The dura mater, when exposed at operation, is often covered with granulations. Sequestra are commoner in the secondary cases.

Symptomatology.—In the primary cases the onset is insidious. A gradually developing frontal headache, which slowly becomes more severe and continuous, is probably the first symptom. Toxæmia of greater or less degree accompanies this. Then an osseous swelling over the frontal region begins to appear. Later, superficial abscess formation and sequestration may follow. Occasionally the patient may exhibit proptosis of one or both eyes.

Royal Society of Medicine

In fact, the symptomatology is like that in acute cases, but very considerably slowed up.

The secondary cases are characterized by acute onset followed by slow progress. In other words there are the characteristic signs and symptoms of acute osteomyelitis, which give place to a slow thickening of the vault, and the formation of multiple sequestra. A very important feature is the accompanying chronic septicaemia, usually with metastases. These may occur anywhere, but are often found in long bones. Brunner¹ suggests that this feature is due to a thrombophlebitis of the superior longitudinal sinus, and consequent pyæmic emboli, rather than to the bony disease itself.

Complications.—The osteitic process may spread to the base of the skull and give rise to lesions of cranial nerves. Septic thrombophlebitis may lead to meningitis or brain abscess, and metastatic cases may develop amyloid disease.

Treatment.—(a) *Prophylactic.*—The secondary cases would not develop if the primary acute cases were treated efficiently and vigorously by radical excision of the diseased bone.

(b) *Active.*—Occasionally the local removal of sequestra and adequate treatment of the underlying sinusitis have been known to halt the spread of this disease, and sometimes the patient may present himself with the condition so advanced that radical treatment cannot be undertaken. But it would seem that among the cases published, wide excision of the osteitic bone is the treatment of choice. This is technically more difficult than in the acute cases, but the patient is usually less ill. The steps of the operation closely follow those already described. The sulphonamides and antibiotics, as would be expected, have little value other than as an aid to operation.

Prognosis.—In all cases the prognosis should be guarded because of the relative difficulty in extirpating the disease process.

I am indebted to a number of my colleagues for help in the preparation of this paper, notably Professor Sir Hugh Cairns and Mr. J. Pennybacker for their helpful criticism and access to the records of the Nuffield Department of Surgery.

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RONALD MACBETH, in reply to Mackenzie Ross, H. V. Forster, Donald Watson and others, said that with reference to the reconstructive

Societies' Proceedings

practice chosen, different plastic surgeons had their different whims and fancies ; he thought that where there was no danger of infection being lit up again an acrylic resin or tantalum plate was of service.

He agreed that there was a place for the use of the anticoagulants heparin and dicoumarol in such cases as cavernous sinus thrombosis. He and his colleagues had not in fact tried these new preparations, probably because there had not been a suitable case.

Mr. Macbeth agreed that they would all try conservative measures before attempting drainage. He had been careful to say in his paper that the drainage treatment was undertaken in acute cases where conservative measures had failed, or where drainage was a matter of urgency.

On the question of how to discover whether an extradural abscess had occurred he could not give a categorical answer, but where trouble of this sort was suspected a "base-line" lumbar puncture would be helpful. An extradural abscess would give a high cell count even in the absence of symptomatology other than that of an obvious frontal sinusitis.

In the cases where ineffective sulphonamide therapy had been used bony changes could often be seen radiologically—changes which had gone on quite quietly. Radiologists stated, however, that it was usual for no bony changes to appear until a week after the clinical symptoms.

On the question of antral infection, operative treatment of the antral infection might be necessary where the help of penicillin was available ; it was usually unnecessary to carry out an operation on the antrum. His third case, which had been treated before penicillin, in fact, had done this.

ABSTRACTS

EAR

The Relation between Hearing Loss for Specific Frequencies and the Distance at which Speech can be Identified. E. THAYER CURRY, Urbana. *Ann. Otol., Rhin. and Laryngol.*, 1949, lviii, 33.

Individual audiometer frequency values for decibel loss indicate little statistical association with the spoken speech score. The correlation for the American Medical Association percentage hearing loss indicates it is not statistically certain that there was any degree of association with the perception of speech.

E. J. GILROY GLASS.

Chorda Tympani Nerve Section and Tympanic Plexectomy: New Technique used in Cases of Deafness, Tinnitus and Vertigo. SAMUEL ROSEN, New York. *Archives of Otolaryngology*, 1949, 1, 81.

In a recent issue of the *Archives of Otolaryngology* (1948, xlvii, 428), the author reported on a new technique used in surgical fenestration of the labyrinth, consisting of avulsing the chorda tympani from its attachment to the facial nerve and laying it over the fenestra nov-ovalis as a pedicle graft. The chorda was thus interposed between the membranous labyrinth and the tympanomeatal flap. Good one-year end-results of all eight consecutive operations in which the chorda tympani nerve graft was used are reported. In certain cases of very severe tinnitus, vertigo and deafness, there has been prompt relief of symptoms after a one-stage operation combining fenestration, section of the chorda tympani and tympanic plexectomy, the technique of which is described and illustrated and the rationale discussed.

R. B. LUMSDEN.

LARYNX

Chondroma and Chondrosarcoma of the Larynx. MELVIN R. LINK, New York. *Ann. Otol., Rhin. and Laryngol.*, 1949, lviii, 70.

Cartilaginous neoplasms of the laryngeal cartilages are comparatively rare. Two cases, chondroma and chondrosarcoma, have been presented and discussed from the standpoint of site, pathology, symptoms, diagnosis and treatment. In discussion on microscopic differentiation between benign and malignant cartilaginous tumours, Lichenstein and Jaffee believe that a cartilage tumour should no longer be regarded as benign if, when viable and not heavily calcified areas are examined, it shows even in scattered fields (1) many cells with plump nuclei, (2) more than an occasional cell with two such nuclei, and especially (3) any giant cell with large single or multiple nuclei or with clumps of chromatin. The only treatment for these neoplasms is surgical excision and in general the same as that for any tumour. It is

Abstracts

essential to remove every fragment of the tumour with a fairly wide margin in order to avoid recurrence. (Author's Summary.)

Rehabilitation of the Larynx in Cases of Bilateral Abductor Paralysis: Open Approach to Arytenoidectomy, with Report of the Past Four Years' Experience. DE GRAAF WOODMAN, New York. *Archives of Otolaryngology*, 1949, I, 91.

The author's posterior open approach to arytenoidectomy is described in detail, along with its creditable quota of cases of successful results.

R. B. LUMSDEN.

ŒSOPHAGUS

Œsophageal Varices. CHARLES B. RIPSTEIN, Montreal. *Canadian Medical Association Journal*, 1949, lxi, 141.

Œsophageal varices frequently cause massive haemorrhages and therefore constitute a very grave complication of portal hypertension. They are responsible for more than one-half of the deaths in this condition. Apart from the mechanical effects upon the vessel walls, intravascular clotting defects further increase the magnitude of the haematemesis—long-continued congestion of the spleen leads to increased destruction of platelets and impaired liver function causes hypoprothrombinæmia.

Two main groups of portal obstruction are now recognized—the intrahepatic, or cirrhotic, type; and the extrahepatic, or Banti's type. The distinction is important both in treatment and in prognosis. In the former group, liver damage is severe, the prognosis is poor and operative treatment carries a high mortality; in the latter, there is little or no impairment of liver function and operation appears to offer good prospect of improvement. Liver function tests should therefore be carried out in all cases of œsophageal varices before deciding upon the method of treatment to be adopted.

The author believes that "the most rational approach to the problem of œsophageal varices has been directed towards establishing communication between the portal and caval venous systems". Such communications must be extensive enough to take the dangerous load off the natural anastomoses in the œsophagus and are effected by an end-to-side anastomosis between the splenic vein and the left renal vein, after removal of the spleen. Such a procedure may divert about 60 per cent. of the portal blood-flow. Removal or obliteration of the varices—by injection of sclerosing agents, ligation of the coronary vein, or resection of the lower œsophagus—is only rational as a secondary procedure, after the portal pressure has been reduced; otherwise recurrence is almost certain. In any case, several months should be allowed to elapse after more radical surgery has been employed, for in many cases the varices slowly decrease in size and are eventually obliterated. The results of lienorenal anastomosis have been very encouraging to date, but a longer follow-up is required before this new approach can be properly evaluated.

J. CHALMERS BALLANTYNE.

Miscellaneous

MISCELLANEOUS

Vertebrated Magnets for Removal of Foreign Bodies from the Air and Food Passages. CHEVALIER JACKSON and CHEVALIER L. JACKSON, Philadelphia. *Ann. Otol., Rhin. and Laryngol.*, 1949, lviii, 55.

The disadvantage of magnets for the removal of foreign bodies in the past has been the poor magnetic energy of the ordinary commercial magnet. Of recent years the demand for a more powerful magnetic energy has led to the development of the alnico magnet by the General Electric Company. This magnet is composed of an alloy chiefly of aluminium, nickel, cobalt and iron, and has great permeability as well as indefinitely long retention of its magnetic powers. Using such a magnet the authors have introduced four vertebrated instruments, ranging from a straight vertebrated rod to one curving to 180 degrees, enabling the magnet to be inserted into almost any branch of the bronchial tree. They advocate only one precaution in its use—apart from avoidance of trauma—the alloy is extremely brittle, and must be handled with the greatest care; should it break, the fragments are polarized and each fragment repels. The fragments can be removed only by use of soft iron which does not polarize.

E. J. GILROY GLASS.

Tantalum in Rhinoplastic Surgery. SAMUEL L. FOX, Baltimore. *Ann. Otol., Rhin. and Laryngol.*, 1949, lviii, 40.

The history of tissue transplants and implants is briefly reviewed, and the advantages and disadvantages of the various materials are discussed. The requirements for an "ideal" implant are also stated, and it is concluded that no such ideal substance has yet been found. A brief review of the history, and of the physical and chemical properties of tantalum is presented. Its introduction into surgery is discussed, and an extensive bibliography of the literature published on the subject is presented. Seven case reports are published in which tantalum implants have been employed successfully by the author in rhinoplastic surgery. (Author's Summary.)

Mitral Stenosis Associated with Left Recurrent Nerve Paralysis. D. F. LEWIS and J. W. SCOTT, Edmonton, Alberta. *Canadian Medical Association Journal*, 1949, lx, 512.

The authors record a single case of rheumatic heart disease, with mitral stenosis and left recurrent laryngeal nerve paralysis, in which hoarseness developed insidiously without any history of respiratory infection. Radiological examination showed enlargement of the left auricle to the left and posteriorly, with accentuation of the pulmonary vascular pattern. A review of the cases reported in the literature led to the conclusion that there was a causal relationship, disputed by some authorities as an anatomical impossibility, between mitral stenosis and left recurrent laryngeal paralysis. The paralysis was thought to be due to the hypertrophied left pulmonary artery pressing upwards on the left recurrent laryngeal nerve and compressing it between the aortic arch and the ligamentum arteriosum.

J. CHALMERS BALLANTYNE.

Abstracts

Anticoagulant Therapy. C. H. JAIME, Hamilton, Ontario. *Canadian Medical Association Journal*, 1949, lxi, 10.

Heparin has been used extensively in the Army and in Hamilton General Hospital for the past eight years, dicoumarol for the past six. Neither embolism nor severe bleeding has occurred during this period. This latter danger is perhaps the greatest objection to the anticoagulants, but such a complication is due to the indiscriminate use of these drugs. Their administration must be controlled by estimations of the prothrombin time—made in this series by a modified Quick technique. Bleeding only occurs when the dose is excessive and the prothrombin time unduly prolonged. It is of interest that dicoumarol was held responsible for three cases of profuse post-operative haemorrhage—two prostatectomies and one hysterectomy—in which therapy had been considered; but in none of these cases was dicoumarol actually given, and one wondered whether this drug was often wrongly blamed in other similar cases reported in the literature. Anticoagulants are considered essential in the treatment of venous thrombosis.

J. CHALMERS BALLANTYNE.

Postgraduate Training in Oto-laryngology. FRANCIS L. LEDERER and JOSEPH G. SCHOOLMAN, Chicago. *Archives of Otolaryngology*, 1949, 1, 59.

A review of the requirements of postgraduate education in oto-laryngology and certain of the difficulties encountered in meeting the problem reveal the scope of the task ahead. To give one course is relatively simple; to give a series of courses is not too difficult; but the integration of an all-inclusive programme requires time, effort and co-operation. The co-operation which must come from the administration offices of the college and from the other departments cannot be too strongly emphasized. The medical college must recognize its responsibility to the public in providing the postgraduate training of the specialist. It can no longer create the medical practitioner and leave to him the task of finding further training where and how he can. The examining boards have determined minimum standards, and the medical colleges must meet this minimum with a formal training programme. The University of Illinois is cognizant of the broadened academic requirements. It has assisted and supported the departments that assumed the necessary task, and it looks forward to the greater place that postgraduate training is to take in the picture of medical education. The department of oto-laryngology will be happy to share the results of its efforts in the developing of programmes at other institutions, and it cordially invites criticism that it may improve its own programme. (Authors' Summary.)

Functional and Anatomic Relation of Spheno-palatine Ganglion to the Autonomic Nervous System. DAVID HIGBEE, San Diego, Calif. *Archives of Otolaryngology*, 1949, 1, 45.

The anatomy of the autonomic nervous system is briefly reviewed in order to establish a logical background for statements in this paper which are contrary to prevailing opinion. The spheno-palatine ganglion has been of clinical interest for many years, chiefly because of its association with pain.

Miscellaneous

It is wholly associated with the parasympathetic nervous system and relays vasodilator and secretory impulses from the superior salivary nucleus to the lacrimal gland and to the mucosa of the upper respiratory tract ; it has no functional relation to the fifth nerve. Nasal membranes, like all other organs of the body, are influenced by the activities of the autonomic nervous system. Observations following paralysis of the sympathetic nervous system, section of the fifth sensory root and administration of atropine suggest the following conclusions :—

- (1) In the nasal mucosa, sensory impulses are conducted by the fifth cranial nerves.
- (2) Vasoconstriction is the dominant effect of stimulation of the sympathetic nerve fibres. Normally, this reflex is inactive because of its high threshold for stimulation.
- (3) The parasympathetic nervous system has a low threshold for stimulation. Vasodilator and secretory fibres from the sphenopalatine ganglion are continuously making adjustments to atmospheric conditions and constitutional states in an effort to maintain a normal nasal membrane. This is the function of the sphenopalatine ganglion. (Author's Summary.)

GENERAL NOTES

THE SEMON LECTURE

UNIVERSITY OF LONDON. The Semon Lecture for 1949, entitled "Tonsillar Function; A Review of the Evidence", will be given in the Lecture Hall of the Royal Society of Medicine, 1 Wimpole Street, London, W.1 (by kind permission), by A. J. Wright, F.R.C.S., Director of Medical Postgraduate Studies, University of Bristol, at 5 p.m. on Thursday, November 3rd, 1949. The Chair will be taken by Professor F. C. Ormerod, M.D., F.R.C.S., Professor of Laryngology and Otology in the University of London.

ROYAL COLLEGE OF SURGEONS OF ENGLAND.

A SERIES of advanced lectures on Otolaryngology for students and consultants will be given during the winter. The first lecture will be given by Professor Geoffrey Jefferson, F.R.S., on "Brain Abscess", on December 1st, at 5 p.m.

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THE members of the Committee of Management and Lecture Staff of the Institute and of the Board of Governors and the Medical Staff of the Hospital, dined together in the Refectory at Gray's Inn Road on Friday, October 7th, to celebrate the establishment of the Professorial Unit and the appointment of Mr. F. C. Ormerod to the Chair.

The Chairman of the Board of Governors and of the Committee of Management (Mr. Ernest E. Taylor) presided. The University of London was represented by Dr. E. R. Boland (Dean of the Faculty of Medicine) and Dr. D. W. Logan (Principal).

The British Post-graduate Medical Federation, of which the Institute is an integral part, was represented by Sir Archibald Gray (Chairman of the Special Purposes Committee) and Professor Sir Francis Fraser (Director).

After the loyal toast, the Institute and the Professorial Unit was proposed by Sir Francis Fraser and responded to by Mr. Taylor and Professor Ormerod. The Dean of the Institute (Mr. C. Gill-Carey) proposed the toast of the University and the Federation, to which Dr. Logan and Sir Archibald Gray responded. The Chair was proposed by Dr. Charles Newman (Dean of the Post-graduate Medical School of London).

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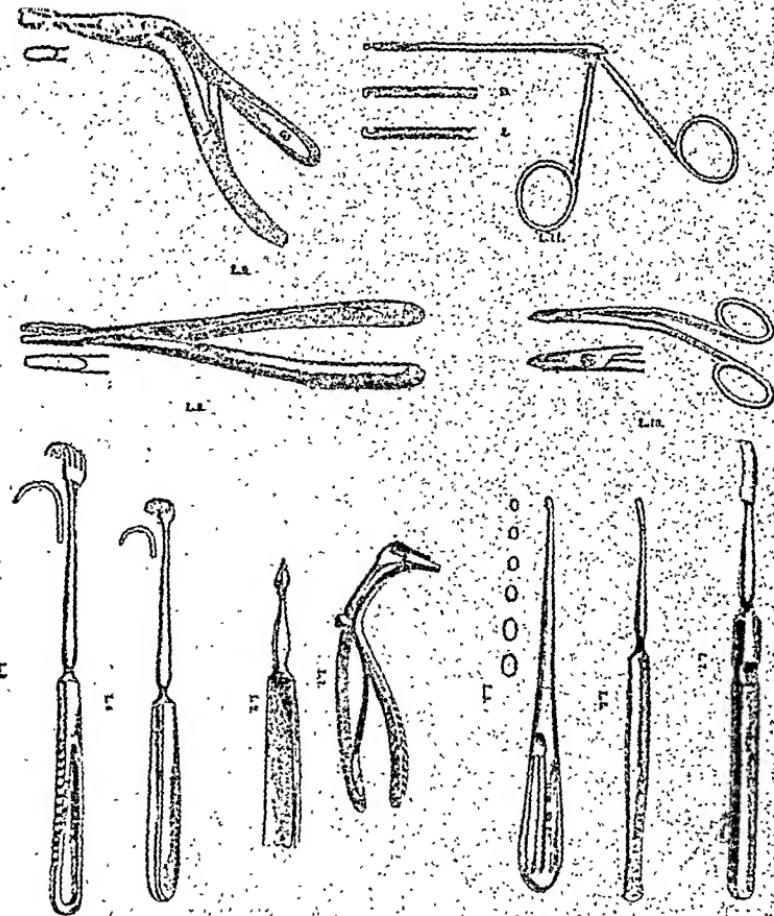
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